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Scenarios for end-use energy demand in Quebec: 1986-2006

Summary Report
Groupe de l'analyse quantitative
et de l'information statistique
Direction générale de
l'analyse économique et financière
Secteur Énergie

OCTOBER 1987

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Since the beginning of the 1970s, the provincial government has been painstakingly analyzing energy demand trends in Québec in an effort to guide its energy policies and action. The present study is a major contribution to this effort.

Developed by the ministère de l'Énergie et des Ressources, **Scenarios for End-Use Energy Demand in Québec: 1986-2006** is an analysis of trends in Québec's energy demand. It brings together precise data and coherent assumptions to provide informed forecasts for Québec's energy future.

I am pleased to present this very instructive document to the public, and hope it will foster fruitful discussion among all the parties involved in the energy sector. It is also my wish that it will contribute to a more efficient management of our energy future.

JOHN CIACCIA
Minister of Energy and Resources

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Scenarios for Québec's energy demand including total wood consumption, in petajoules (Médée 3 - SC1, SC2 and SC3)

Scenarios for Québec's energy demand including total wood consumption, in natural units (Médée 3 - SC1, SC2 and SC3)

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EXECUTIVE SUMMARY

As part of its studies on energy demand trends in Québec over the long term, the ministère de l'Énergie et des Ressources analyzed energy consumption for the period 1986 to 2006. During this analysis, Department analysts simulated three different socio-economic scenarios, based on two economic growth assumptions (strong growth and slow growth) and three assumptions for increases in the price of international crude oil (major increase, moderate increase, limited increase). Scenario 1 combines strong growth with a substantial rise in oil prices, while scenario 2 is based on low growth and a moderate price increase. Scenario 3 uses a combination of strong growth and a limited increase in oil prices.

The following results were obtained on the basis of these assumptions and detailed considerations on the socioeconomic context and the price of the various energy forms:

. According to all three scenarios, there should be a recovery in the growth of overall energy demand over the next 20-year period. Based on our estimates, this recovery, which has been under way since 1984, will be relatively moderate (an average annual growth rate of 1.2% in scenario 1, 0.7% in scenario 2 and 1.4% in scenario 3).

In all three scenarios, energy demand will grow two to three times less rapidly than economic activity. This phenomenon bears witness to the fact that energy consumption and economic growth are less closely linked than in the past.

A comparison of the results obtained in scenarios 1 and 3 shows that patterns of total energy consumption in Québec do not appear to be very sensitive to changes in the international oil market, at least within the limits of the variations envisaged in these two scenarios.

We should also point out that, in all three scenarios, energy consumption per thousand dollars of output will continue to decline.

. On the basis of the results obtained, we were able to draw several major conclusions with regard to changes in the energy balance according to energy form.

- According to the three scenarios studied, electricity will become the predominant form of energy used in Québec over the next 10 years. Our results suggest that the share of

electricity in the total energy balance (including non-conventional energy forms) will increase from 37% in 1986 to 47% (scenarios 1 and 2) or 42% (scenario 3) by 2006. The average annual growth rate of electricity demand will amount to 2.4% (scenario 1), 1.8% (scenario 2) or 2.0% (scenario 3).

- In all three scenarios, the importance of oil would continue to decline, although at a slower rate than over the past decade. It is estimated that the share of oil in the energy balance will drop from 40% in 1986 to 28% (scenario 1), 30% (scenario 2) or 32% (scenario 3) by 2006.

- Regardless of the scenario studied, the growth in natural gas demand can be seen to stop around 1991. Subsequently, demand should either remain stationary (scenarios 1 and 3) or decline (scenario 2), so that by the end of the period, there would either be a slight reduction (scenario 2), no change (scenario 1) or a slight increase (scenario 3) in the share of natural gas in the total energy balance (scenario 2). Relative to its 1986 level of 14%, in 2006 the share of natural gas would either drop to 13% (scenario 2), increase to 16% (scenario 3) or remain stationary (14% - scenario 1).

- In all three scenarios, the share of non-conventional energy forms in Québec's energy balance would not change significantly. Our results suggest that this share, which accounted for slightly less than 8% in 1986, will increase to 9% (scenario 1) or 8% (scenarios 2 and 3) by 2006. Forest and urban biomass would remain, by far, the main forms of non-conventional energy used in Québec. However, certain other forms would probably begin to play a role in the transportation sector.

. The following phenomena were observed with regard to energy demand in the various consumption sectors:

- In all three scenarios, the relative share of industrial energy demand should increase, despite improvements in the energy efficiency of the industrial sector. Even in scenario 3, the abandonment of petroleum products by most industrial consumers is not called into question. On account of the inroads made by electrotechnology in this sector, and even for stoking purposes, natural gas will come into competition with electricity.

- There does not seem to be a close relationship between residential energy consumption and the rate of economic activity or oil price increase assumptions used in this study. Demographic trends, the construction of new housing in accordance with new insulation norms, and the shift away from oil toward electricity explain the very moderate growth of energy demand in the residential sector.

- In scenarios 1 and 3, energy consumption in the commercial sector should develop in accordance with energy demand in the economy as a whole. Its growth rate would be slightly lower according to scenario 2. In all three scenarios, it can be noted that there should be a major decline in the importance of the role played by oil and that natural gas and electricity should compete with one another to take over the markets left open by petroleum products. The outcome of this rivalry is directly related to the comparative prices of these two forms of energy and a difference can be noted in the results obtained in scenarios 1 and 3.

- Although to varying degrees, all three scenarios bear witness to a renewed growth in energy demand in the transportation sector. This confirms the turnaround observed since 1984. In all three cases, energy demand growth should accelerate at the end of the period. In addition, demand in the transportation sector seems to be sensitive to the crude oil price assumptions used in this study. In the three scenarios, the transportation sector still constitutes a basically captive market for petroleum products in 2006.

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SCENARIOS FOR END-USE ENERGY DEMAND IN QUÉBEC: 1986-2006

In January 1985, the ministère de l'Énergie et des Ressources made public its forecasts of Québec's energy demand for the period up through 1995.[1] For the first time in its official work, the Department used a methodology - the EDEN model - employing a "technico-economic" approach in its analysis of trends in end-use energy demand. The EDEN model is, in effect, a simplified version of a more complex, disaggregated model (Médée 3 Québec) built jointly with the INRS-Énergie using concepts developed by the Institut économique et juridique de l'énergie de Grenoble.[2] In the fall of 1984, the Department launched a project using the Médée-3-Québec model to analyze long-term trends in Québec's energy demand; the period studied covered the years 1986 to 2006. As part of its analysis, the Department simulated three different socioeconomic scenarios, combining two economic growth assumptions and three assumptions for increases in the price of international crude oil. In addition to the three scenarios, two "alternative" simulations were performed, each of which varied certain financial ratios of Hydro-Québec. The purpose of this document is to present the results of this study as well as a preliminary analysis of them, on the distinct understanding that they cannot be disassociated from the economic scenarios used.

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(1) Québec End-Use Energy Demand 1990-1995. Collection études et recherches, secteur Énergie, ministère de l'Énergie et des Ressources. December 1984.

(2) The work carried out jointly by the MER, the INRS-Énergie and the IEJE of Grenoble for the construction of the Médée-3-Québec model was described at a seminar held in Montréal in October 1983. See L'implantation de Médée 3 au Québec: la méthodologie et les résultats. Collection études et recherches. August 1984.

CHAPTER 1. METHODOLOGY

Since the methodology used in this study has already been described elsewhere,[1] we will discuss only very briefly the characteristics of the approach used. Let us simply recall that the Mēdēe models belong to a family of forecasting methods, known as technico-economic methods, which differ from traditional econometric methods in three main ways. First, energy demand is analyzed according to use, each use being identified at a very disaggregated level. Secondly, useful energy needs are determined for each use, useful energy being the amount of energy required by a consumer to satisfy a particular need or to carry out the specific activity related to the use identified. Thirdly, technico-economic methods lay special emphasis on scenarios, which take into account both unquantifiable factors and factors directly dependent on political choices. Technico-economic models can be considered tools that allow a specific end-use energy demand to be associated with a particular scenario.

Technico-economic methods have proven to be especially useful in analyzing energy demand ever since the economic crisis of the 1970s put an end to the relatively stable relationship between energy consumption and the major economic aggregates. The Mēdēe approach, developed in the early 1970s by the Institut ēconomique et juridique de l'ēnergie de Grenoble, provides a certain number of original solutions to several problems related to using technico-economic models. Basically, this approach offers practical and viable solutions to problems that arise in collecting the statistical data needed to operate such models. In addition, the Mēdēe method devotes special attention to the elaboration of scenarios, laying emphasis on the need to adopt coherent sets of assumptions in making up a given scenario.

Mēdēe 3 Quēbec, which was developed by the ministère de l'Énergie et des Ressources and the INRS-Énergie, is in keeping with the various technico-economic methods and the Mēdēe approach. However, it adapts their various characteristics to the particular economic situation which prevails in Quēbec. In Mēdēe 3 Quēbec, energy demand and trends in this demand are estimated using two relational structures: the first structure (the model itself) is a highly disaggregated diagram showing the cause and effect relationships that explain end-use energy demand. The second structure is a hierarchical arrangement of scenario elements describing trends in the socioeconomic and political context, itself defined on the basis of an analysis provided by several study groups.

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(1) See notes 1 and 2, page 1.

The Médée-3-Québec diagram (that is, the model itself) inserted in this document illustrates, in schematic form, the method used to calculate end-use energy demand. Under a predefined socioeconomic scenario, the model is used to calculate, at a very disaggregated level, the activities and needs related to energy demand. These needs and activities (for example, passenger-kilometers travelled, liters of hot water used) are then converted into useful energy needs, on the basis of assumptions about trends in the per unit energy consumption of the equipment used to satisfy them (automobile performance, water-heater efficiency, etc.). By taking into account assumptions about the price of the various energy forms, the behavior of economic agents (subject to choice), and technical constraints (captive market, availability of a given form of energy, etc.), the model is used to calculate, within the framework of a given socioeconomic scenario, end-use energy demand in Québec for the various study horizons.

The scenario itself is worked out using a complex procedure involving several task forces set up both in and outside the Department (see the diagram "Steps in the Médée-3-Québec exercise - 1984-1986", page 5).

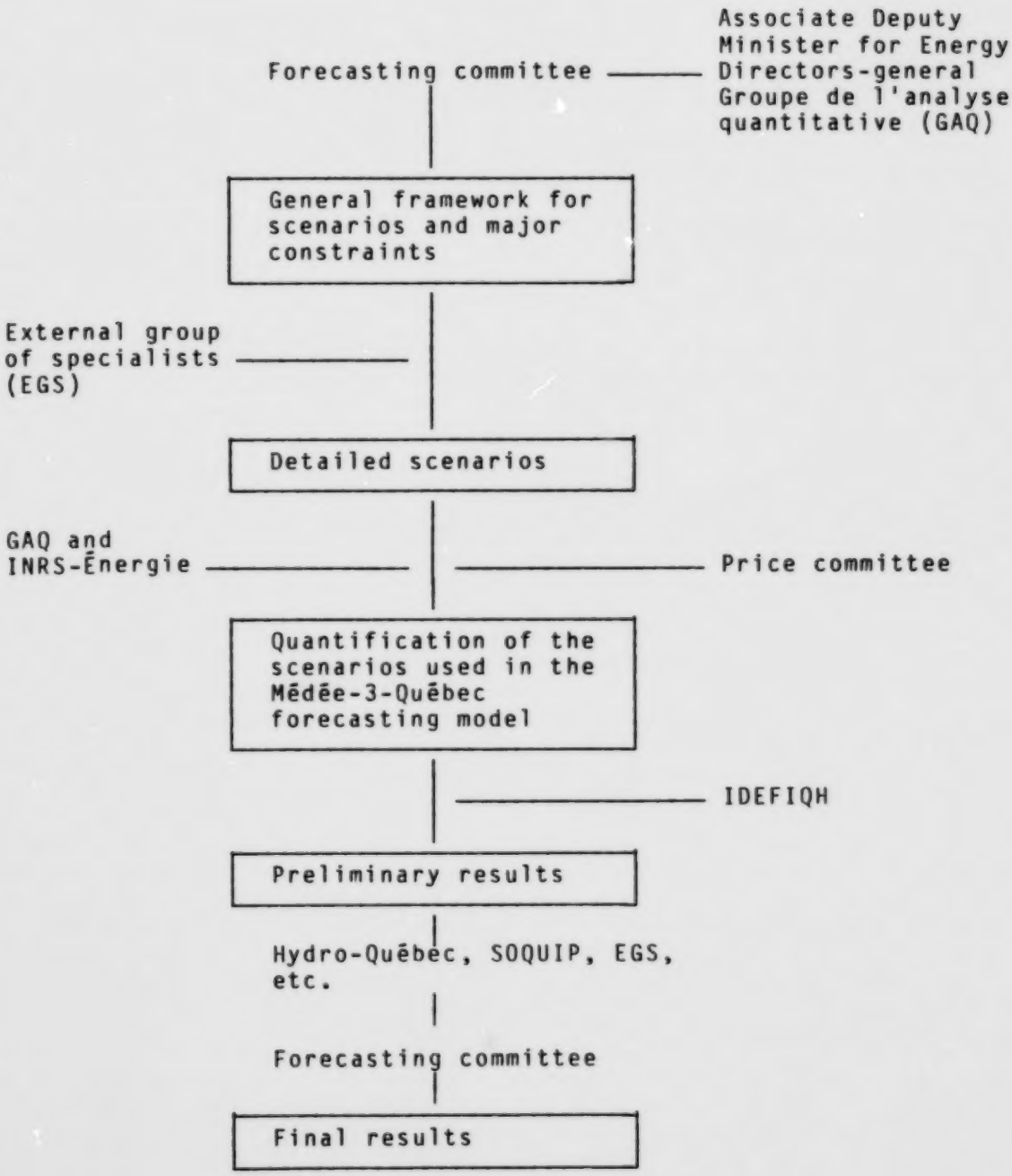
Actually, in the study whose results are presented here, the definition of scenarios and the calculation of end-use demand were very closely linked. Briefly, the exercise proceeded as follows:

- In August 1984, a forecasting committee, made up of decision makers from the secteur Énergie, defined the broad lines and constraints of the two socioeconomic scenarios that it wanted to have simulated (a strong growth scenario and a slow growth scenario, called scenarios 1 and 2, combined with two scenarios for oil price increases).

- A group of specialists from outside the Department then met, in October 1984, to define detailed socioeconomic scenarios that would comply with the framework identified by the forecasting committee.

- From November 1984 to May 1985, these socioeconomic scenarios were then quantified, that is, put into a form that could be used by the model. This task was carried out by the Groupe de l'analyse quantitative of the secteur Énergie, in collaboration with analysts from the INRS-Énergie and following consultation with a certain number of experts both in and from outside the Department.

DIAGRAM
STEPS IN THE MÉDÉE-3-QUÉBEC EXERCISE - 1984-1986



- From March 1985 to June 1985, another group of analysts from the secteur Énergie worked out price scenarios for the various energy forms that would comply with the socioeconomic scenarios selected.

- During the summer of 1985, the Department ran iterations of Mēdēe 3 Québec and another model that it had developed, the IDEFIHQ model,[1] until their results converged.

- In the fall of 1985, the results of scenarios 1 and 2 were presented to the forecasting committee of the Department and then discussed with certain external bodies such as Hydro-Québec and SOQUIP. As a result of these discussions, several of the assumptions we had adopted were refined.

- At the request of the forecasting committee, two alternative scenarios were simulated with the model during the winter of 1985-1986. These scenarios imposed certain constraints on Hydro-Québec's rates of return (scenarios 1.14 and 2.14).

- The results were then studied by the forecasting committee in March 1986. The performance of the international oil market since the beginning of 1986 led the committee to request that a third scenario be simulated using a lower oil price than that assumed in scenarios 1 and 2.

- In April 1986, the external group of specialists was convened to analyze the results obtained in the first two scenarios and their alternative simulations, and to lay the foundations of the third socioeconomic scenario.

- From May to July 1986, a special committee of analysts from the Department set up a new price scenario, while the GAQ quantified the other elements of the third socioeconomic scenario.

- From August to September 1986, the calculations were performed for the third simulation requested. As in the case of the first two scenarios, these calculations were done by iterating between the Mēdēe-3-Québec and IDEFIHQ models.

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(1) For Image du Développement FInancier d'Hydro-Québec. The IDEFIHQ model simulated Hydro-Québec's capital expenditure plan using a given electricity demand. On the basis of the results obtained, we were able to deduce the tariffs that would have to be set by this Government corporation and to compare them with the electricity rate assumptions used in Mēdēe 3 Québec.

This description of the procedure followed during the first official implementation of Mēdēe 3 Québec prompts two comments, on both the period of time covered by the exercise (approximately two years) and the number of groups directly or indirectly involved. In both cases, we might obviously be inclined to point out the cumbersomeness of this forecasting tool and the risks taken with respect to the coherence of the results as a whole. However, now that this first exercise is complete, the Mēdēe-3-Québec model seems to be extremely workable from a methodological point of view. It was able to perform the simulations requested within a relatively short period of time, especially in the case of the two alternative scenarios and scenario 3. With regard to the number of groups involved, it should be emphasized that their ideas and comments enriched the content of the exercise considerably. The Mēdēe-3-Québec model, on account of its clearness and flexibility, has fulfilled our expectations and proven to be a very precious analytical tool for the energy sector. However, at the outset, enough time had to be devoted to setting up and quantifying a coherent and credible socioeconomic framework.

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CHAPTER 2. SCENARIOS

As specified above, we analyzed long-term trends in Québec's energy demand by simulating three socioeconomic scenarios, the first two of which were subjected to a complementary sensitivity analysis. These three scenarios differ from one another with respect to their basic assumptions about economic growth and changes in the international crude oil price. Their other characteristics, whether related to the global socioeconomic context or the price of the various energy forms, were defined within the framework of these basic assumptions.

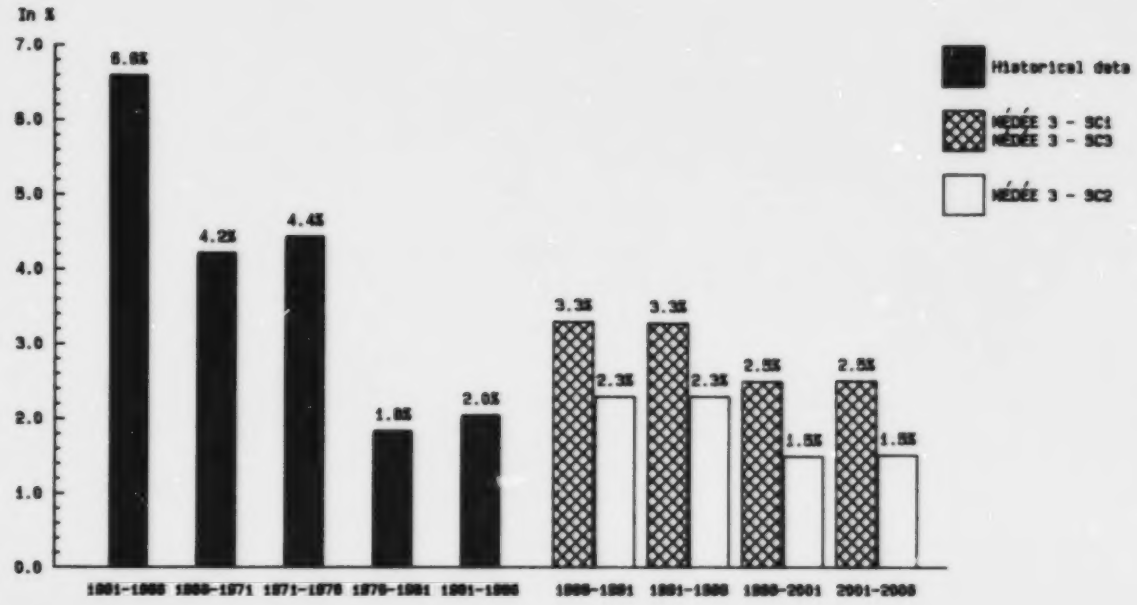
I - Basic assumptions: economic growth and movements in the price of international crude oil

A) Economic growth

The international economic context is the same in the three scenarios. It is characterized by freer trade and economic liberalism. The principles underlying the international division of labor operate quite freely: energy-intensive industries are relocated primarily in countries where the various energy forms are the least expensive, while labor-intensive industries are moved to areas where labor is very cheap. In all three scenarios, we assume that the average annual growth rate of the U.S. economy will amount to 2.8% until 1996 and then decline to 2% for the period 1996-2006.

Within this international economic context, the three scenarios differ with respect to the perfomance of the Québec economy. In scenarios 1 and 3 (strong growth scenarios), we assume that Québec will turn its comparative advantages to profit and perform better than the reference economy (U.S. economy). The sustained activity of Québec's export industries should allow the economy to grow by 0.5 points more than that of the United States - or by 3.3% per year for the period 1986-1996 and 2.5% per year for the period 1996-2006. In scenario 2 (slow growth scenario), on the other hand, we assume that the performance of Québec's export industries will be less satisfactory and that the overall growth of the economy will be 0.5 points lower than in the United States. As a result, the annual growth rate of Québec's GDP, in scenario 2, is assumed to be 2.3% for the period 1986-1996 and 1.5% for the period 1996-2006.

Graph 1 - Growth scenarios for Québec's GDP
(average annual growth rate)
1961-2006

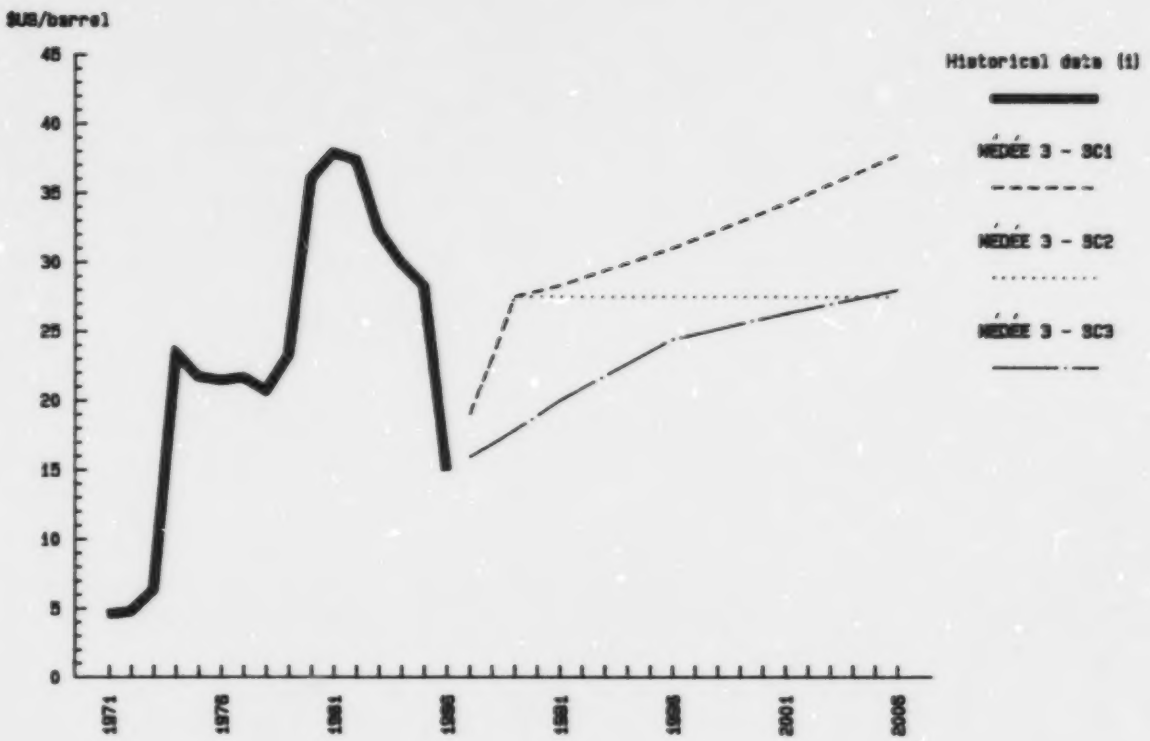


B) The price of international crude oil

The second basic assumption that differentiates the three scenarios concerns the increase in the price of international crude oil. We initially chose two possible scenarios, one involving a substantial price increase and the other, an increase no greater than the general rate of inflation. However, as specified above, the crude oil price collapse in early 1986 made us readjust these two scenarios and formulate a third one based on lower oil prices.

The three oil price scenarios tested may be defined as follows. All three start with an average price of $15 per barrel (1985 U.S. dollars) for 1986 as a whole. In the first scenario (associated with the strong economic growth scenario - scenario 1), we assume that the price of crude oil will return, by 1989, to the levels recorded in the fall of 1985 and that, from 1990 up through the end of the period under study, it will increase by 2% per year in real terms, reaching $28 US (1985 dollars) in 1991 and $38 US by 2006.

Graph 2 - Price scenarios for international crude oil
(in 1985 US dollars)
(1971-2006)



(1) For 1986, preliminary data based on weekly average prices observed during the first six months.

The second price increase scenario (associated with the slow economic growth scenario - scenario 2) is identical to the first for the period 1986-1989. However, in the second scenario, we assume that the price of crude oil will stabilize in real terms at the level reached by 1989 and then remain stationary until 2006.

On account of the disturbances on the international oil market at the beginning of 1986, we decided to elaborate a third scenario for changes in the price of international crude oil. Contrary to the first two scenarios, which were based on a review of existing literature, the third was elaborated following a direct analysis of supply and demand conditions on the international market. We adopted the following assumptions in the light of this analysis:

- For the subperiod 1986-1996, it is estimated that the price of $15 per barrel cannot be considered an equilibrium price insofar as it would be too low to allow the exploitation of the deposits needed to meet the demand anticipated for that period. The highest possible price on the market is estimated at $24 per barrel (1985 U.S. dollars). We assume that this price will be reached by the end of the subperiod (1996), and that the increase from $15 to $24 dollars per barrel will take place gradually.

- For the subperiod 1996-2006, it is also estimated that the price of $24 per barrel cannot be considered an equilibrium price given the conditions of supply and demand that can be anticipated for that period. We therefore assume that the price of crude oil will continue to be "pulled" up by demand from 1996 to 2006 and that its annual growth rate will amount to 1.6% in real terms. On the basis of this assumption, the price of crude oil should reach $28 per barrel (1985 U.S. dollars) by 2006.

Two points should be emphasized here:

- The third oil price scenario is based on a low-increase assumption, although not the lowest one imaginable. For Department analysts, the current exercise was also aimed at setting up a scenario with a certain degree of probability. It can therefore be noted that the crude oil price assumed for the end of the period in this scenario is slightly higher than that used in the second one.

- Before pursuing this discussion any further, we should explain the way in which the oil price assumptions were associated with the three scenarios for economic growth.

- We should first recall that the trends in international economic growth are assumed to be identical in the three scenarios: on account of a lack of conclusive data, we decided not to attempt to define possible future relationships between oil prices and economic growth at the international level.

- Given the presence of various conflicting influences within the Québec economy, each economic growth scenario could have been systematically associated with each of the three oil price scenarios. However, such an approach would have required six different simulations. We therefore decided to give precedence to three hypotheses and to associate the strong economic growth scenario with assumptions for high and low oil price increases (scenarios 1 and 3), and the slow growth scenario with the moderate price increase assumption (scenario 2). This approach should be kept in mind in analyzing the results obtained.

II - The socioeconomic context

The detailed socioeconomic characteristics of the scenarios selected were defined within the framework of the basic assumptions presented above. These characteristics are related to demography, in the broad sense of the word, and to each of the various sectors of economic activity.

A) Demography

With regard to demographic variables properly speaking, we assume that, from 1986 to 2006, the population will grow at an average annual rate of 0.5% in scenarios 1 and 3, and 0.4% in scenario 2. For the same period, the average annual growth rate of households is estimated to be 1.5% in scenarios 1 and 3, and 1.3% in scenario 2.

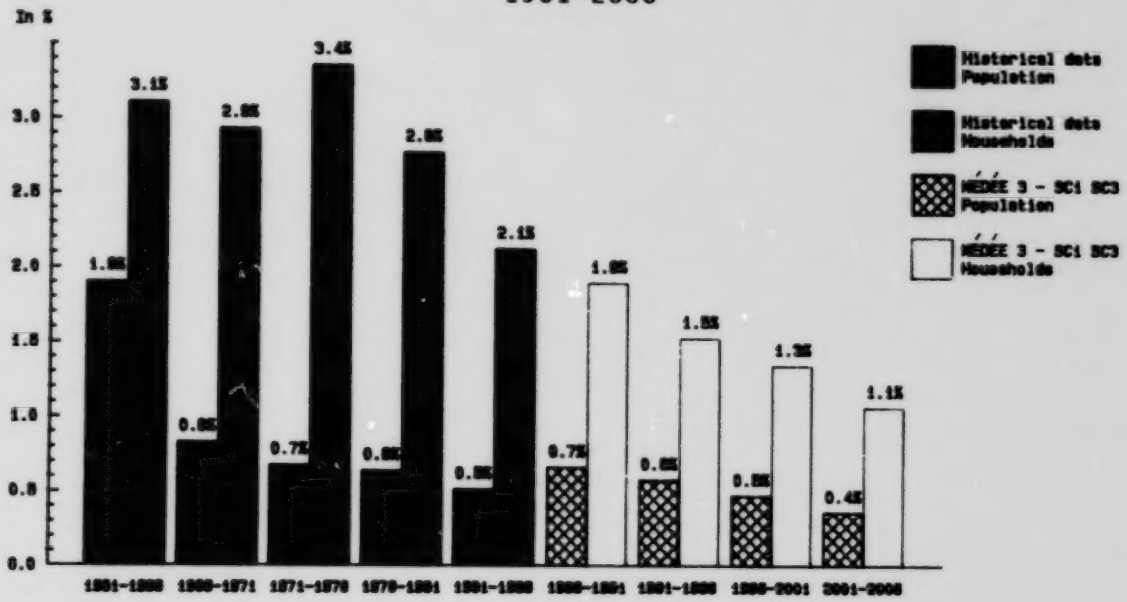
It can be noted that, in all three scenarios, there should be a marked slowdown in population growth in relation to past trends. It may be recalled that, for the period 1970-1980, the annual growth rate of households was 2.9%. The assumptions adopted here are based on estimates related to various demographic phenomena (for example, birth, death and fertility rates), estimates obtained for the most part from the BSQ. The difference between scenario 2 and scenarios 1 and 3 can be entirely attributed to the migration assumptions adopted: in the strong growth scenarios (scenarios 1 and 3), we assume that the good performance of the Québec economy will have a somewhat positive effect on immigration. As will be noted below, these population growth assumptions have a direct and major impact on energy consumption in the residential and transportation sectors.

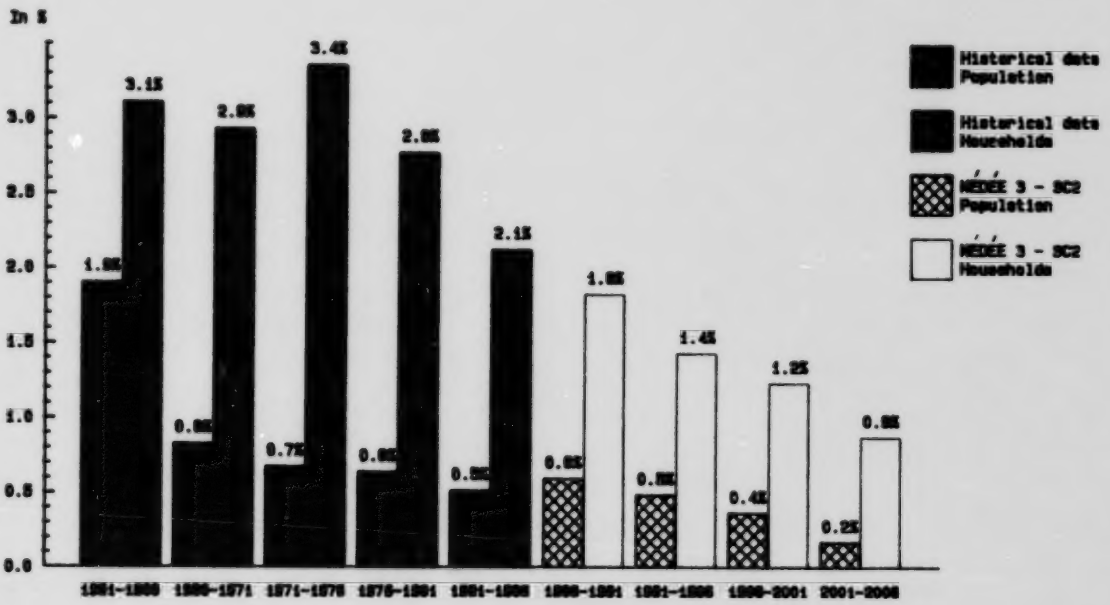
In addition to the assumptions related to strictly demographic variables, others were selected for the distribution of income. We assume, in scenario 2, that income will increase at approximately the same rate in each of the four categories of households selected, but that there will be a somewhat greater disparity in scenarios 1 and 3 (strong growth hypotheses). The combination of stronger growth and greater income disparity will lead to an increase in the percentage of households belonging to the $45 000 and over category (1981 dollars): this percentage, which amounted to 9% in 1986, will reach 25% in scenarios 1 and 3, and 13% in scenario 2. On the other hand, in scenario 2, the percentage of households in the $15 000 and under category will not fall significantly below its 1986 level of 36%: it will reach 30% by the end of the period, compared to 27% in the other two scenarios.

B) Socioeconomic characteristics by sector of activity

In this section, we will briefly describe the assumptions adopted for each economic activity sector.

Graphs 3 and 4 - Growth scenarios for Québec's population and households
(average annual growth rate)
1961-2006





a) Residential sector

Assumptions were adopted for rates of ownership per household for each income group. In all three scenarios, we assume that ownership rates will increase in each income group, although at a somewhat slower pace than over the past decade. We also assume that the share of apartments occupied by their owners will increase during the period, accounting for up to 12% of the units owned by households with an income of over $30 000. On account of the relative importance attributed to each income group, these same assumptions produce, however, somewhat different results for the housing stock characteristics in the three scenarios.

In the residential sector, assumptions were also adopted for heating needs, household appliances and hot water consumption.

- As far as heating is concerned, we assume that useful energy savings in the old housing stock (housing built before 1981) will be relatively modest and vary little from one scenario to another. In fact, most energy savings have already been made. We also assume, however, that there will be a more marked improvement in the energy efficiency of new housing in scenario 1 than in scenarios 2 and 3. We estimate that, in these last two scenarios, a single-family home built in 2006 will be 31% more efficient than one built in 1981; the same home is expected to be 42% more efficient in scenario 1.

- In all three scenarios, we assume that average consumption per household will remain constant for energy needs related to hot water and household appliances. Data presently available on the impact of various conflicting phenomena (increased distribution, greater efficiency, smaller households) suggest that the needs of households in this regard will remain relatively stable.

b) Industrial sector

Growth assumptions for the industrial sector were adjusted by sector of activity, so as to comply with the spirit of the three scenarios. As a result, in scenarios 1 and 3 (strong growth scenarios), export industries should perform well, but there should be a decline in the relative importance of labor-intensive sectors (textile, clothing, leather, etc.). The assumptions we adopted are related to growth in the value added by light industry (29 spheres of activity) and production trends in energy-intensive industries (EII) (14 spheres of activity). Table 1 presents the main assumptions selected. In all three scenarios, special attention is devoted to changes in the production levels of certain energy-intensive industries and to the penetration of new electrical processes.

Table 1 - Changes in gross domestic product in the secondary sector 1983-2006

Sphere of activity	1983[1]	1983-1986[2]	Scenarios 1 and 3		Scenario 2	
			1986-1996[2]	1996-2006[2]	1986-1996[2]	1996-2006[2]
Construction	1 366.4	3.3%	3.0%	2.0%	1.8%	1.0%
Manufacturing	6 307.6	3.3%	3.4%	2.7%	1.8%	1.4%
. Food and beverages	767.5	1.8%	3.5%	2.6%	1.5%	1.1%
. Tobacco	99.1	3.9%	1.2%	0.9%	0.3%	0.3%
. Rubber and plastic products	201.9	3.7%	3.5%	2.6%	2.1%	1.6%
. Leather	66.5	0.8%	0.1%	0.1%	1.1%	0.8%
. Textiles	345.6	-3.4%	0.2%	0.2%	1.1%	0.8%
. Hosiery	121.0	0.4%	1.2%	0.9%	1.4%	1.0%
. Clothing	427.9	0.4%	1.3%	1.0%	1.3%	1.0%
. Wood	283.1	6.8%	2.0%	1.4%	1.5%	1.1%
. Furniture and furnishings	127.2	6.9%	4.0%	3.1%	2.1%	1.6%
. Paper	667.1	2.8%	2.1%	2.3%	1.0%	1.0%
. Printing and publishing	429.7	3.7%	3.7%	2.8%	2.1%	1.6%
. Primary metals						
- iron and steel	144.0	3.4%	2.1%	1.6%	1.0%	1.0%
- other metals	61.4	4.7%	3.6%	2.9%	3.0%	1.2%
- aluminum	157.1	2.0%	7.6%*	2.1%*	7.6%	2.1%
- alumina and other metals	150.8	2.0%	1.8%	1.6%	1.1%	0.7%
. Metal products	348.7	8.0%	4.8%	3.7%	2.1%	1.6%
. Machinery making	213.5	7.0%	6.6%	5.1%	3.6%	2.7%
. Transportation equipment	422.4	5.1%	4.8%	3.7%	2.0%	1.5%
. Electrical products	416.9	6.4%	4.8%	3.7%	1.6%	1.2%
. Nonmetallic mineral products	174.5	1.4%	2.1%	1.8%	0.4%	1.0%
. Petroleum and coal products	52.0	-3.7%	-0.6%	0.4%	1.0%	-0.7%
. Chemical industry	482.6	2.0%	2.5%	2.3%	2.2%	1.7%
. Assorted manufacturing industries	147.1	5.3%	4.8%	3.7%	2.1%	1.6%
Sector as a whole	7 674.0	3.3%	3.3%	2.6%	1.8%	1.3%

*In this sector, scenario 3 is different from scenario 1. In scenario 3, we assume that the average annual growth rate will be 6.2% for the period 1986-1996 and 2.3% for the period 1996-2006.

(1) In millions of 1971 constant dollars.
(2) Average annual growth rate.

1°) Trends in the production capacity of energy-intensive industries

Among the many spheres of activity considered, four deserve special attention: the aluminum, pulp and paper, iron and steel, and petrochemical industries. A special analysis of trends in production activities in each of these spheres had to be carried out, for they account for a major share of total energy consumption in the industrial sector (around 65% of industrial energy consumption in 1986). Moreover, certain phenomena specific to each of these spheres of activity were likely to affect their development within a given scenario.

In the case of the aluminum industry, we estimate in the three scenarios that the availability and low cost of electricity should lead to a marked increase in production capacity, partly through the relocation of facilities from other areas, especially the United States, in Québec.

- In scenarios 1 and 2 (strong and slow growth), we assume that, by 1996, the production capacity of the aluminum industry will be slightly more than double that recorded in 1981. In Québec, production capacity is expected to rise from 834 000 t in 1981 to 1 951 000 t in 1996. We also assume that slower growth after 1996 will result in a capacity of 2 400 000 t by 2006; this implies that a new production unit will be added in each of the five-year subperiods.

- In scenario 3, we estimate that the lower level of oil prices should have an impact on the development of the aluminum sector in Québec. Such prices will probably slow down the relocation of aluminum plants in the province, while the profitability of certain North American plants will likely improve. In this scenario, we estimate that the production capacity of the aluminum industry by 1996 would be lower than that in the first two scenarios: we assume that the difference will amount to 240 000 t, or the production capacity of a single aluminum plant. As in scenario 1, we expect that after 1996 an additional unit of production will be set up in each of the two five-year subperiods, bringing the production capacity of the aluminum industry up to 2 160 000 t.

In the case of the pulp and paper industry, we assume that production capacity in scenarios 1 and 3 (strong growth scenarios) will undergo only moderate growth, lower than the average growth of the industrial sector as a whole. This phenomenon can be explained by problems related to the availability of forest resources in Québec. For the period 1986-2006, it is assumed that production capacity will grow at an average annual rate of 2.2%; however, this assumption presupposes the successful implementation of forestry policies aimed at increasing the resource.

Although we assume that similar forestry policies will be implemented in scenario 2 (slow growth scenario), the pulp and paper sector is expected to grow less rapidly in this scenario, or at an annual rate of 1.0% for the period 1986-2006. This phenomenon can be attributed to Québec's poorer performance on foreign markets during this period.

As far as the iron and steel industry is concerned, we excluded, in all three scenarios, the possibility that SIDBEC would close down. For the period 1986-2006, we assume that the annual growth rate of the value added will be 1.8% in scenarios 1 and 3, and 1.0% in scenario 2.

In the case of the petrochemical industry, all three scenarios assume that the Montréal industry will remain in operation.

2°) The penetration of new electrical processes

One of the major unknowns in the energy picture of the industrial sector is the penetration of "new electrical processes". These processes include those electrotechnologies (induction, infrared, etc.) that are likely to replace, especially in the pulp and paper industry, a number of current processes based on hydrocarbons. The introduction of electrotechnologies can be expected to have a considerable impact: they will probably allow electricity to penetrate new markets in the industrial sector and, on account of their high energy efficiency, will likely have a significant effect on energy consumption by the sector as a whole.

For this reason, we had to be especially careful in selecting assumptions for the penetration of this type of technology. The markets affected are still not very well known, and studies are presently under way to determine more precisely the penetration potential of electrotechnologies and the conditions conducive to their introduction.[1] The assumptions we selected were formulated on the basis of presently available data and a theoretical analysis of the factors at work. Table 2 presents the assumptions adopted for each of the three scenarios and for the two alternative simulations (scenarios 1.14 and 2.14). It can be noted that scenario 1 (strong growth and high oil prices) is based on the most optimistic assumption for the penetration of electrotechnologies. Indeed, sustained economic growth and high oil prices will probably be two factors conducive to the penetration of new electrical processes.

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(1) It should be pointed out that INRS-Énergie recently launched a study, on behalf of the ministère de l'Énergie et des Ressources, on the penetration of electrotechnologies in the pulp and paper and primary metal industries.

Table 2 - Electrotechnology-related electricity consumption (in TWh) 1986-2006

	Scenario 1	Scenario 2	Scenario 3	Scenario 1.14	Scenario 2.14
1986	0.1	0.1	0.1	0.1	0.1
1991	5.0	1.1	1.1	5.0	1.1
1996	7.5	3.1	3.0	6.9	2.5
2001	9.0	5.0	5.0	8.3	4.3
2006	10.0	6.1	8.0	9.8	6.0

c) The service sector

Assumptions were adopted in all three scenarios for changes in the value added in the service sector by all of the 19 spheres of activity concerned (see Table 3).

Two points should be emphasized here:

- First, in all three scenarios, we expect that there will be a change in a general economic trend observed since the war, namely, the trend toward faster growth in the service sector relative to the economy as a whole. In scenarios 1 and 3, we assume that this phenomenon will no longer prevail and that the service sector will grow at the same rate as the rest of the economy. In scenario 2, on the other hand, it is assumed that the average annual growth rate of this sector will surpass overall economic growth by 0.2 percentage points.

- Secondly, in all three scenarios, we assume that structural modifications will have an impact on the service sector. Although these modifications will be basically the same, their scope will vary depending on the scenario. For example, in all three scenarios, it is assumed that there will be slower growth in the public administration and education sectors, and more rapid development in those related to health and leisure. We assume that structural modifications will be more pronounced in scenarios 1 and 3 than in scenario 2. These assumptions are based on the combined effect of several long-term socioeconomic factors (aging of the population, changes in consumer tastes, higher incomes per household, changes in the role of the State, etc.).

Table 3 - Changes in gross domestic product in the service sector 1983-2006

Sphere of activity	1983[1]	1983-1986[2]	Scenarios 1 and 3		Scenario 2	
			1986-1996[2]	1996-2006[2]	1986-1996[2]	1996-2006[2]
. Finance	3 846.2	3.9%	3.3%	2.5%	2.5%	1.7%
. Transportation	1 390.6	4.8%	2.5%	2.0%	1.9%	1.2%
. Communications	1 208.0	4.1%	4.8%	3.8%	3.4%	2.2%
. Electricity, gas and water	1 162.5	5.8%	3.4%	2.7%	2.9%	1.9%
. Public administration	1 985.1	0.7%	1.1%	0.9%	1.0%	1.0%
. Wholesale trade	1 383.1	4.8%	3.6%	2.8%	2.6%	1.7%
. Food	269.0	4.2%	3.0%	2.3%	2.3%	1.5%
. Shopping centers	841.0	5.0%	3.5%	2.7%	2.5%	1.5%
. Garages	422.2	5.2%	3.7%	2,9%	2.3%	1.3%
. Other retail businesses	519.2	5.0%	3.5%	2.7%	2.2%	1.2%
. Public hospitals	912.8	1.1%	1.1%	0.9%	1.7%	1.1%
. Health services	772.4	6.0%	5.5%	4.3%	4.0%	2.6%
. Schools	784.7	-0.3%	0.1%	-1.1%	-0.8%	-0.5%
. Colleges	135.6	3.5%	3.0%	2.4%	2.3%	1.5%
. Universities	211.5	3.5%	3.0%	2.4%	2.3%	1.5%
. Hotels and motels	136.8	2.2%	1.1%	0.9%	0.8%	0.5%
. Restaurants	401.1	6.5%	5.5%	4.3%	3.9%	2.6%
. Leisure facilities	232.4	5.9%	4.9%	3.9%	3.6%	2.3%
. Other services	2 111.5	4.8%	3.3%	2.6%	2.4%	1.6%
. Health	1 685.2	3.4%	3.5%	3.0%	2.9%	2.0%
. Education	1 131.8	0.9%	1.1%	0.4%	0.3%	0.3%
Sector as a whole	18 723.6	3.9%	3.2%	2.6%	2.3%	1.6%

(1) In millions of 1971 constant dollars.
(2) Average annual growth rate.

d) The transportation sector

- The socioeconomic characteristics of each of the three scenarios selected have a direct impact on several factors that determine transportation energy demand.

As shown on the diagram inserted in this document, the Mēdēe-3-Quēbec model makes a distinction between passenger transport and goods transport and, in both of these cases, between urban transport and interurban transport. A further disaggregation takes travel motives into account in order to determine transportation needs. These needs are then distributed among the various modes of transport available (air, marine or rail transport, individually owned car, truck, etc.).

With regard to transportation needs, all passenger transport motives are closely related to population growth, its regional components and impact on the age pyramid. This is especially true in the case of study-related travel. Passenger transport motives are also related to some of the other socioeconomic characteristics defined in the assumptions adopted for each scenario: for example, the level of economic activity in all sectors, in the case of work-related travel; and income levels, in the case of transport needs related to "personal matters", "leisure" and "shopping".

In all three scenarios, goods transport needs are also directly dependent on phenomena related to economic activity. For example, in all three scenarios, iron and grain transport needs in Quēbec ports are related to the assumptions adopted for iron ore production and the amount of grain in transit through Quēbec.

In addition, the assumptions selected for the distribution of transportation needs by available modes of transport are linked to some of the socioeconomic characteristics of the scenarios. In the case of urban transport, passenger transportation needs are based on age, income and the regions considered, while in the case of interurban transport, they are dependent on income and the distance travelled. In the case of goods transportation needs, the breakdown by modes of transport is directly dependent in some instances on the type of goods transported (grain is shipped through Quēbec), or on scenario elements related to cost trends or transportation policies implemented by public authorities.

- Factors more closely linked to energy, properly speaking, also had to be taken into account in formulating the assumptions for the transportation sector.

These factors are primarily related to the penetration of non-conventional forms of energy in this sector. In all three scenarios, we reject the possibility that electricity will be

used in rail transport during the period studied. We also reject the assumption that methanol will be used directly as fuel for cars and trucks. However, scenario 1 differs from scenarios 2 and 3 with respect to its assumptions on the use of natural gas for vehicles (NGV) and the addition of methanol or ethanol to gasoline. In scenario 1, we assume that non-conventional energy forms will capture a larger share of the market than in the other two scenarios: under normal circumstances, higher oil prices should promote greater use of alternative fuels.

As in the case of the other economic activity sectors, we estimated "unit consumption" for the transportation sector, or the anticipated energy savings for a given type of equipment. For all transportation equipment considered, the assumptions chosen in each scenario were differentiated on the basis of crude oil prices. In the case of the automobile, changes in the income level of households were also taken into account. Actually, a peripheral model, AUTO, was used to measure the global impact of detailed assumptions about the price elasticity of the distribution of purchases by each type of household according to five vehicle types.

III - Prices of the various energy forms

As specified above, the three scenarios analyzed were set up using two basic assumptions for economic growth and trends in the price of international crude oil. These two basic assumptions were then used to define the global socioeconomic context and the price movements for the various energy forms. Obviously, the price levels set for each form of energy largely explain the results obtained during the exercise. We should therefore describe how we calculated the various energy prices using the assumptions on the price of international crude oil.

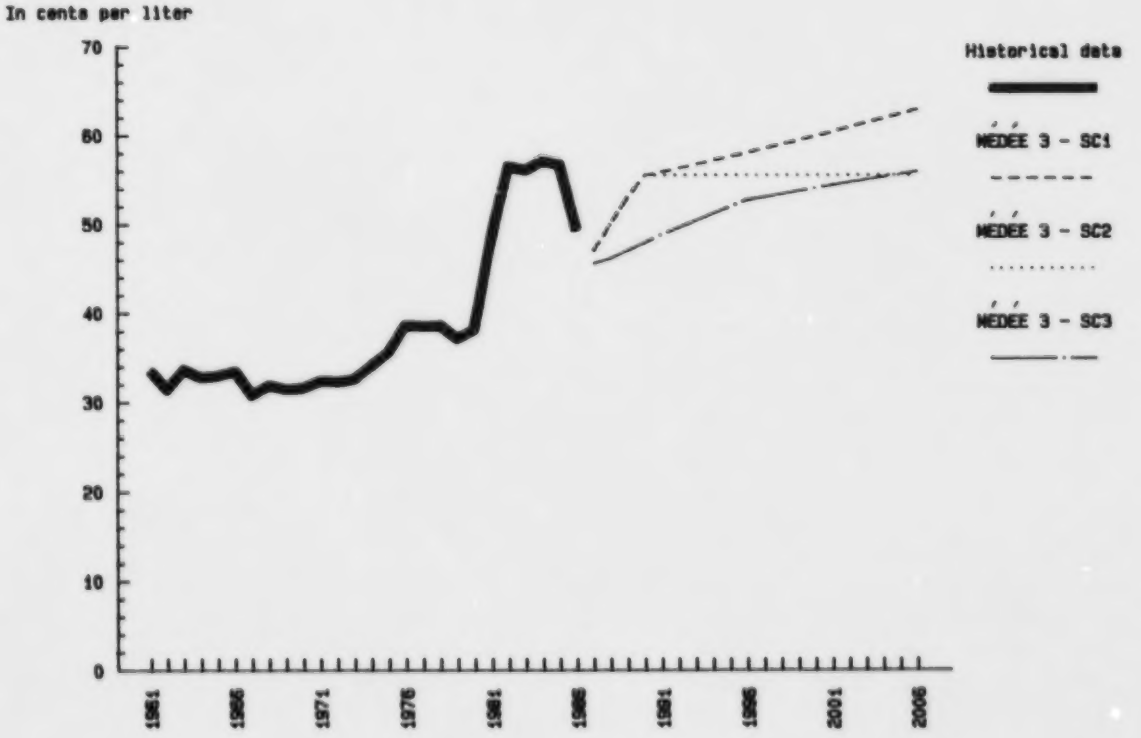
A) The price of petroleum products

The prices of the various petroleum products were established on the basis of the three scenarios for oil price increases (substantial increase - scenario 1; moderate increase - scenario 2; limited increase - scenario 3) using similar calculation methods. Assumptions were selected for the margins of distribution, refining and marketing applicable to the light fuel oil sold in the residential and commercial sectors. An assumption was also adopted for the distribution margin of heavy fuel oil. In addition, in all three scenarios, we assume that the price of heavy fuel oil will be equivalent to 85% of that for crude oil for the 1986-1990 period and that it will stabilize at 90% after that date. Other assumptions were defined for inflation rates and the average energy efficiency of combustion equipment during the period studied. These assumptions are in keeping with the general assumptions of each scenario.

The consumer price of gasoline was set using the peripheral model, AUTO, which calculated the combined effect of the crude oil prices and the government-imposed tax. In all three scenarios, we assume that the ratio between taxes and the price of crude oil will decrease as oil prices climb and the automobile stock becomes more fuel-efficient.

It can be noted that, as a result of these calculations, the real price of gasoline (regular leaded gasoline) in scenario 1 would rise by 40% between 1986 and 2006, while the price of crude oil would increase by 150%. According to scenario 3, there would be a 25% increase in the price of gasoline, compared to an 87% hike in that of crude oil.

Graph 5 - Average selling price of gasoline in Québec
(1985 dollars)
1961-2006



B) The price of natural gas

Two natural gas prices were calculated for each of the crude oil price scenarios: one for the city-gate price and another for when it reaches the various distribution points.

a) The city-gate price of natural gas

The following basic observation was a determining factor in defining the various assumptions selected. Despite the fact that natural gas consumption in Québec has grown sharply over the past few years, consumption levels are still not high enough in this area to significantly affect gas prices in the rest of Canada (in 1985, the Québec market accounted for 10% of the Canadian market and 1% of the North American market). The Canadian natural gas industry is concentrated in Alberta, and its profitability and development are highly dependent on gas exports from Canada to the United States (in 1985, such exports amounted to nearly 1 000 billion cubic feet, or more than half the total Canadian consumption).

The price of natural gas is therefore sensitive to conditions on the U.S. market. We assume in all three scenarios that the situation described above will persist, especially since deregulation should remove all veritable obstacles to such adjustments.

We also consider that the development of the U.S. natural gas market will be identical in the three scenarios: highly competitive up to 1990; then, gas prices will be driven up as U.S. reserves are not renewed fast enough to satisy demand. We therefore assume that, by 1990, Canadian gas will have to be competitive with both American gas and the heavy fuel oil available on the markets involved. Subsequently, the price of Canadian gas would be determined solely by that of heavy fuel oils on certain specific markets.

On the basis of these assumptions, we then calculated the city-gate price of natural gas paid by Gaz Métropolitain, inc. within the framework of each scenario, by taking the following elements into account: the difference in the cost of transporting gas from Alberta to Eastern Canada and the U.S. border, estimated fluctuations in exchange rates, and the fact that the unit revenues brought in by Canadian producers on the Canadian market should be equivalent to those yielded by sales on the U.S market.

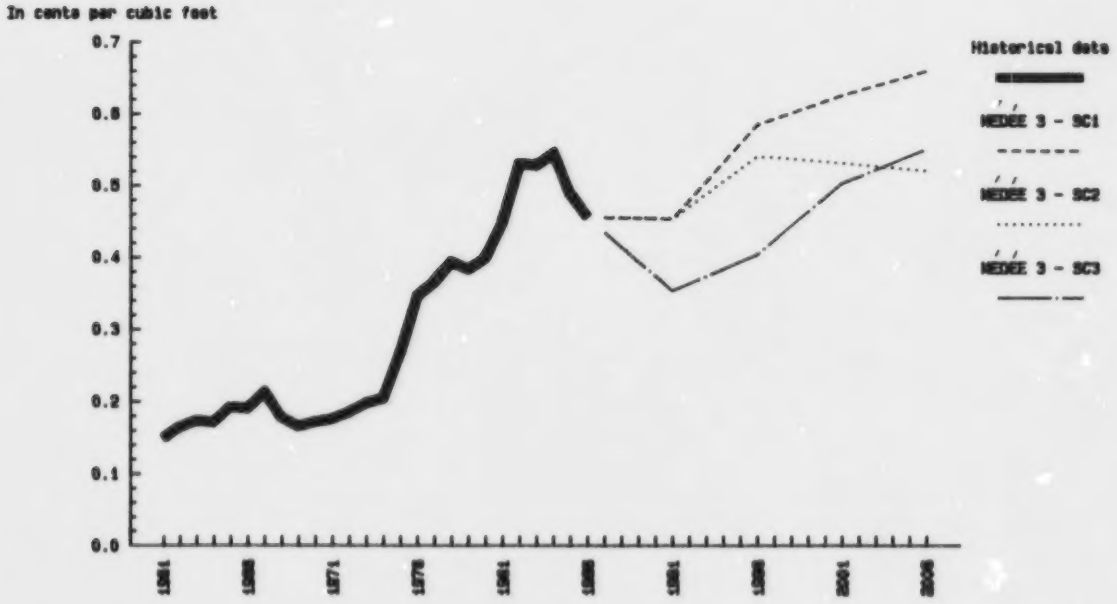
b) The price paid for natural gas by the Québec consumer

Once we had calculated the city-gate price paid by Gaz Métropolitain, inc., we then assumed - on the basis of past observations - that further adjustments would be made by the distributor, in response to changes in the competitive position of natural gas.

In practice, the natural gas price scenario defined above could have led, in some scenarios, to a situation in which natural gas distributors were severely threatened on markets they consider strategic by the rates set by Hydro-Québec - rates which, as demonstrated above, are related only indirectly to the price of crude oil. We therefore estimated that, if such a situation were to arise, the Régie de l'électricité et du gaz would authorize distributors to engage in certain cross-subsidization schemes in order to protect their prime markets.

This situation did, in fact, arise in scenarios 1 and 2, where we had assumed that cross-subsidization schemes would allow distributors to deal with competition from electricity in the industrial sector by increasing prices in the commercial and residential sectors. On account of the low oil price used in scenario 3, no such adjustments were necessary.

Graph 6 - Average selling price of natural gas in the industrial sector (1985 dollars) (1961-2006)



C) The price of electricity

In elaborating the scenarios, we were faced with a major methodological problem when we began to formulate the assumptions for electricity prices. Contrary to other energy forms, whose prices are primarily dependent in Québec on phenomena related to the supply and demand situation on North American and international markets, electricity rates are directly determined by demand on the Québec market. The process involved is complex and brings a number of interacting factors into play. On the one hand, electricity rates influence demand on the various markets. However, on the other, electricity demand has a determining effect on Hydro-Québec's installations program, whose funding, in turn, has a direct impact on electricity rates and, therefore, on the competitive position of electricity and the demand for this energy form.

It therefore seemed necessary to at least make some attempt to take these relationships into account during the simulations. This was done by alternately using the Mēdēe-3-Québec model and two other models, MOBIDIHQ[1] and IDEFIHQ[2] developed by the Department, in order to analyze certain characteristics of electricity supply in Québec. An iterating process was established between demand, as defined during preliminary calculations with Mēdēe-3-Québec using pre-established electricity rates, and supply, as determined by the MOBIDIHQ and IDEFIHQ models. On the basis of the demand forecasts supplied by Mēdēe-3-Québec, the IDEFIHQ model was used to identify an appropriate investment plan for Hydro-Québec and to calculate production costs. These costs were then converted into rate increases by the MOBIDIHQ model.

This iterative procedure was repeated several times for each scenario. As a result, we were able to determine the equilibrium rates finally used in the simulations. These rates were of course defined for each consumption sector.

It can be noted that, according to all three scenarios, there should be an improvement in the competitive position of electricity on the various markets. This improvement is more pronounced in scenarios 1 and 2 than in scenario 3. Graph 7 shows changes in the average selling price of electricity in relation to that of natural gas in the industrial sector for each of the three scenarios.

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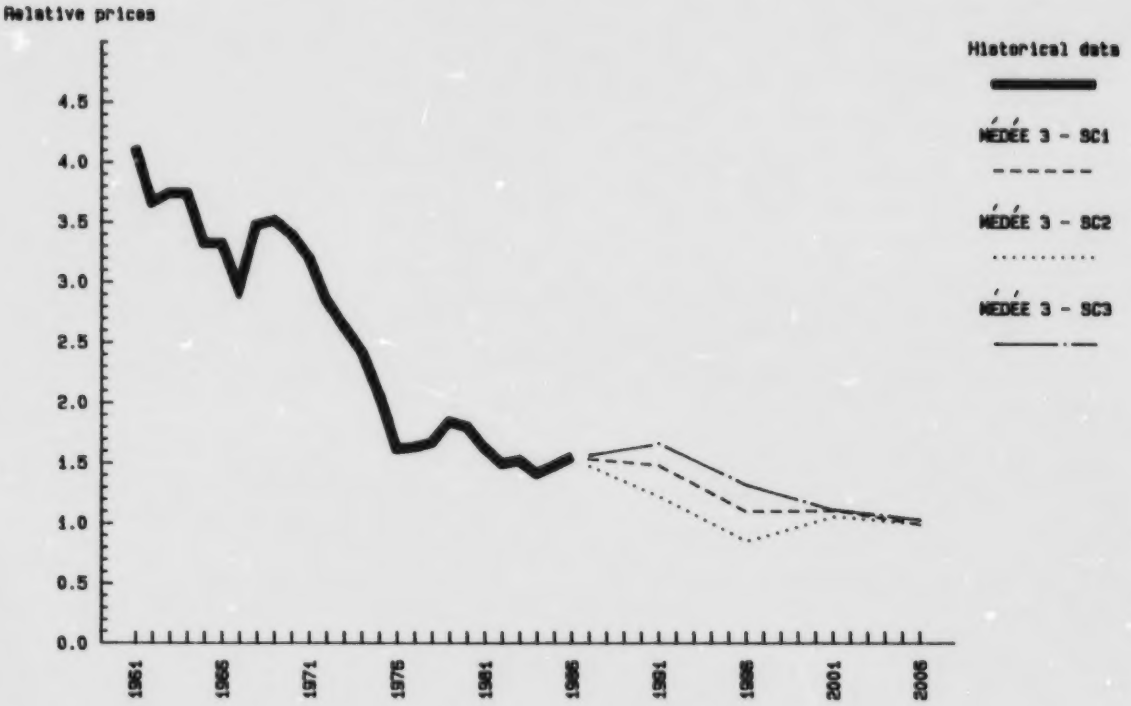
(1) For Modèle Bidirectionnel d'Hydro-Québec.
(2) For Image du Développement Financier d'Hydro-Québec.

Graph 7 - Average selling price of electricity (regular rate) in relation to that of natural gas in the industrial sector 1961-2006



Three additional points should be emphasized here:

- First, in the simulations performed, changes in electricity rates were related in at least two ways to changes in the price of international crude oil. On the one hand, the price of crude oil was one of the variables used to determine export revenues and, therefore, the rates imposed by Hydro-Québec. On the other hand, in the iterative procedure, changes in electricity demand with respect to a given rate were based on the competitive position of electricity in relation to other energy forms, including petroleum products.

- Secondly, in all three scenarios, electricity rates were determined on the basis of coherent assumptions concerning salaries and inflation. Prices of surplus electricity and of electricity intended for export were set on the basis of changes in

the price of heavy fuel oil. With regard to the volume of electricity exported, we adopted similar assumptions in all three scenarios: only those contracts already signed with Vermont, NEPOOL and NYPA (formerly PASNY) were taken into account.

- Thirdly, we assumed in all three scenarios that Hydro-Québec would maintain its current self-financing (25%) and interest rate payment criteria. No dividend would be paid to the Government, except in cases where, for a given year and despite the lack of a rate increase, a financial surplus would be recorded once these criteria had been met.

As mentioned above, in the case of scenarios 1 and 2, the Department conducted a sensitivity analysis concerning financial criteria that would have to be met by Hydro-Québec. In the two additional simulations (scenarios 1.14 and 2.14), this Government corporation had to record a 14% minimum return on equity. In both scenarios, this new constraint did not have a significant effect on rates until after 1991. By 2001, we estimated that the average price of electricity would be 10% higher in scenario 1.14 than in scenario 1, and 15% higher in scenario 2.14 than in scenario 2. This constraint had less of an impact after 2001; it can be noted that, by 2006, rates would be only 5% higher in the two simulations than in the corresponding scenarios.

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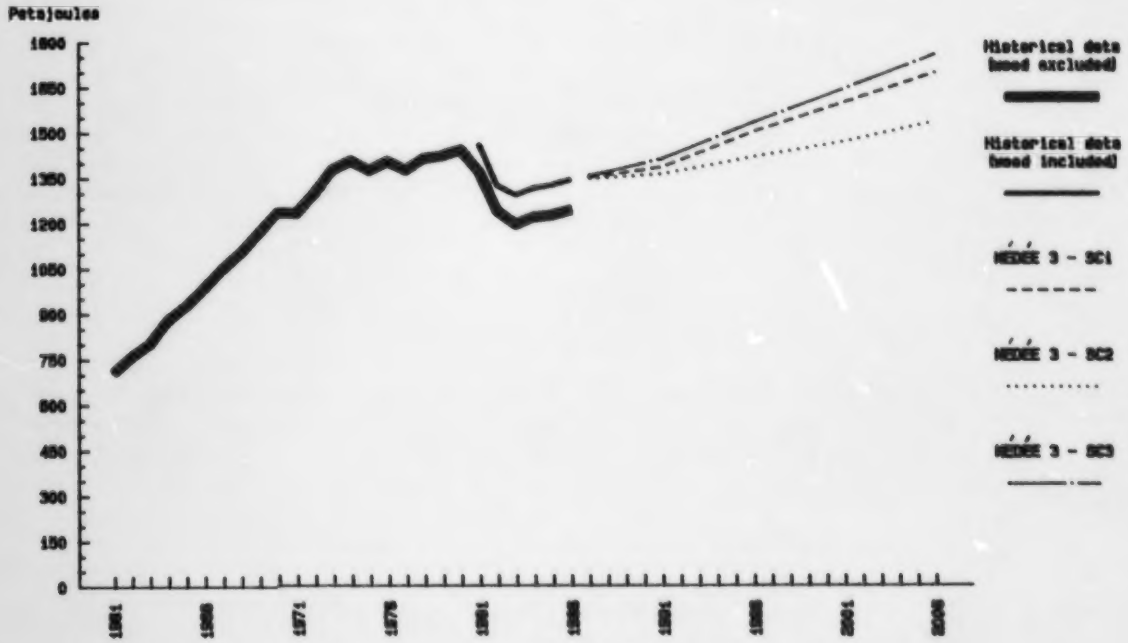
CHAPTER 3. RESULTS: TOTAL ENERGY DEMAND AND DEMAND BY ENERGY FORM

The simulations of change in energy demand, based on the scenarios described above, produced a series of results that provided us with an evaluation of energy consumption in Québec for the next 20 years. The tables inserted in the backflap of this document present the results for each of the three scenarios. The data obtained are expressed in natural units, tonnes of oil equivalent (toe) and petajoules (PJ).

Before analyzing the results obtained for each consumption sector (residential, commercial, industrial, transportation), we should present a number of general conclusions on total energy demand and its distribution among the various energy forms (electricity, oil, natural gas, and non-conventional forms of energy).

I - Total energy demand

Graph 8 - Total energy consumption in Québec
(in petajoules)
1961-2006



It can be noted immediately that, in all three scenarios, there should be a recovery in the growth of total energy demand over the next 20 years. This recovery, which has been under way since 1984, would probably be relatively moderate, however. It would amount to 1.2% per year in scenario 1, 0.7% in scenario 2, and 1.4% in scenario 3. On the basis of these estimates, total energy consumption in Québec would reach 40.6 million toe (1 700 PJ) in scenario 1, 36.8 million toe (1 539 PJ) in scenario 2, and 42.0 million toe (1 761 PJ) in scenario 3 by 2006; these consumption levels are 27%, 14% and 13% higher respectively than those recorded in 1986. It should be noted that, on the average, total energy demand in Québec increased by 5.5% per year between 1960 and 1973, with no growth recorded between 1973 and 1980. From 1980 to 1983, energy consumption declined by an average of 5.6% per year. Our results suggest that total energy consumption would return to its 1980 level around 1996 in scenarios 1 and 3, but that a similar recovery would not likely occur before 2005 in scenario 2.

As explained above, the three scenarios simulated differ from one another with respect to their basic assumptions on economic growth and changes in the international price of oil. By analyzing the results, we obtain an evaluation of the way in which these two variables are related to total energy demand in Québec.

A) The impact of economic growth on total energy demand

As seen above, scenarios 1 and 2 differ with respect to both their economic growth assumptions (strong economic growth in scenario 1; more moderate economic growth in scenario 2) and anticipated increase in the price of international crude oil (sharp increase in scenario 1; more moderate increase in scenario 2). As will be seen below, the alternative assumptions chosen with regard to oil price movements seem to have little effect on total energy demand. Therefore, by comparing the results obtained in scenarios 1 and 2, we will be able to shed some light on the relationships that exist between economic activity and total energy consumption in Québec.

These relationships can be perceived in two ways: either by analyzing a given scenario through time, or by bringing the concept of elasticity into play and studying, for the same period, the energy demand changes associated with varying rates of economic growth.

- The same phenomenon can be noted in all three scenarios with respect to change in the relationship between economic growth and energy demand through time. For the period 1986-2006, the ratio between energy demand and economic growth would be 0.41 according to scenario 1, 0.37 in scenario 2, and 0.47 in scenario 3. This means that, in all three scenarios, energy demand

in Québec should grow two to three times less rapidly than economic activity throughout the period studied.

These results are a good illustration of a phenomenon also observed in other industrialized nations, namely, that energy demand and economic growth are less closely linked than in the past. In Québec, the ratio between the two was 1.0 between 1961 and 1972. The International Energy Agency (IEA) has noted a similar phenomenon in Europe: in 1983, this agency estimated that the ratio between energy consumption and economic growth would amount to 0.46 for the period 1985-2000, a result very similar to that obtained for Québec.

The similarity between the data obtained for Québec and Europe merits special attention. In all three scenarios, major gains in energy efficiency should be made in Québec, especially with respect to automobiles and new housing. These gains would probably be more substantial than those anticipated by the IEA for European countries. However, they would be offset by increased energy intensity in the industrial sector, on account of the rapid growth of certain energy-intensive industries (in particular, the aluminum industry).

This conclusion can be confirmed by examining the situation in the United States. The IEA has estimated that the ratio between energy demand and economic growth should be 0.26 for the 1985-2000 period. In this case, energy savings, in the transportation sector in particular, would not be offset by increased energy intensity in the industrial sector.

It should be pointed out that, in all three scenarios, the growth in the gap between energy demand and economic growth should tend to level off by the end of the period. Between 2001 and 2006, the ratio would increase to 0.48 in scenario 1, 0.58 in scenario 2, and 0.54 in scenario 3. This phenomenon can largely be explained by slower improvements in energy efficiency at the end of the period.

- The analysis of scenarios 1 and 2 allowed us to shed further light on the relationship between energy demand and economic activity. By comparing the results obtained in the two scenarios, we were able to calculate the GDP elasticity of energy demand, that is, the effect of changes in economic growth on energy consumption.

It can be noted that, for the period 1986-2006, there is a difference of one percentage point between the average annual economic growth rates obtained in the two scenarios (2.9% compared to 1.9%). A difference of 0.5 points can also be noted with respect to the annual average increase in energy demand (1.2% compared to 0.7%). For the period 1986-2006 as a whole, the GDP

elasticity of energy consumption in Québec should be equivalent to 0.5. This means that, within the context of scenarios 1 and 2, an additional annual increase of 1% in economic growth would produce an average annual increase of 0.5% in energy consumption.

We should re-emphasize that these results can only be understood within the context of the scenarios studied. The GDP elasticity of the energy demand calculated here is directly dependent on the characteristics of the additional economic growth and, especially, on the distribution of this growth among the various industries. It is obvious that the impact of changes in economic growth on energy demand will vary considerably depending on whether this growth is distributed proportionately among the various sectors of activity or whether, on the contrary, it benefits some more than others (for example, heavy industry or the service sector). For instance, the fact that we adopted identical assumptions for the productive capacity of aluminum plants in scenarios 1 and 2 tended to decrease the GDP elasticity of energy demand, that is, the impact of changes in economic growth on energy consumption as measured by comparing the two scenarios.

B) The impact of oil prices on total energy demand

If we now analyze the results obtained in scenarios 1 and 3, an interesting conclusion can be drawn with regard to the impact of oil price trends on total energy demand.

As specified above, scenarios 1 and 3 differ with respect to their underlying assumptions for increases in the price of international crude oil (scenario 1: sharp increase; scenario 3: limited increase). It can be noted that, despite the difference in energy prices, our results as a whole vary relatively little. For each of the two subperiods (1986-1996 and 1996-2006), the overall energy demand would grow at an annual average rate of 1.2% in scenario 1 and 1.4% in scenario 3. We estimate that, by 2006, total energy demand in scenario 3 would be only 3.6% higher than that recorded in scenario 1.

A single consumption sector is largely responsible for the differences in the results: the transportation sector. Energy consumption by this sector would be 12% higher according to scenario 3 than to scenario 1; in other words, it would account for over 80% of the difference in total consumption between the two scenarios.

We can therefore conclude - and this is one of the major findings of this study - that the pattern of total energy consumption in Québec will not be very sensitive to changes in the international oil market, at least within the limits of the variations envisaged in scenarios 1 and 3. The oil price drop assumed in scenario 3 will not be large enough and, in particular, prolonged

enough to have a significant effect on the general behavior of energy consumers. Many of the factors that determine demand are relatively inflexible, and this phenomenon explains the partial, if not complete, irreversibility of certain changes in energy consumption.

C) Energy efficiency

The phenomena described above with regard to the relationships between energy consumption and economic activity can be explained in part by changes in "energy efficiency". The various factors at work should be analyzed in greater depth.

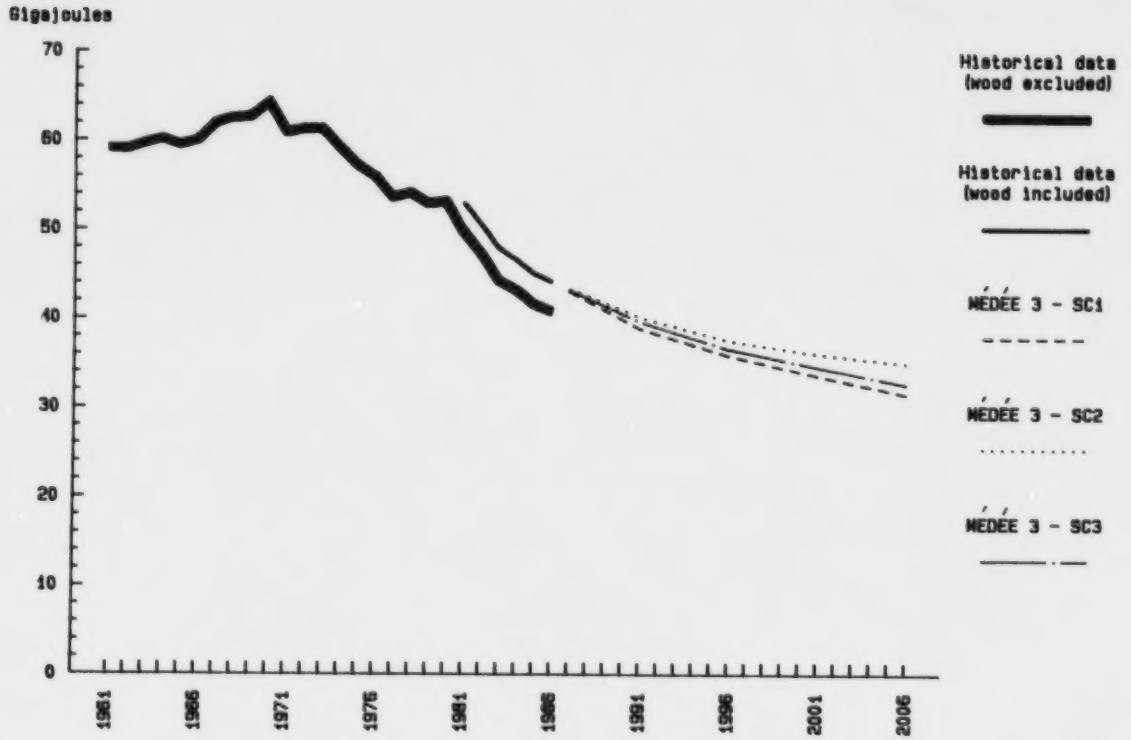
The ratio expressing energy consumption in thousands of dollars of GDP (1971 dollars) provides a measure of improvement in energy efficiency. This ratio was more or less stable in Québec between 1961 and 1973. From 1974 onward, energy consumption per thousand dollars of output began to decline (see Graph 9), and the drop was especially pronounced between 1980 and 1983.

It can be noted that, in scenarios 1 and 2, this downturn would continue until 2006, although at a constantly declining rate. We should emphasize that the same result was obtained in scenario 3, even though this scenario was based on the assumption that there would be a limited increase in the price of oil. These results suggest that the Québec economy should continue to improve its energy efficiency over the next 20 years.

To illustrate the importance of this phenomenon, we calculated what Québec's energy demand would be by 2006 if we assumed that energy consumption per thousand dollars of output remained at its 1986 level. In scenario 1, for example, energy demand would be 40%, or 16.1 million toe (672 PJ), higher than the result actually obtained. This is a highly significant variation in energy consumption.

The decline in energy consumption per thousand dollars of output can be attributed to a number of factors, some of which can be quantified using the example presented in the preceding paragraph. In scenario 1, the decrease in energy consumption per thousand dollars of output can be explained particularly by a decrease in the per unit consumption of the industrial sector (4.5 million toe or 190 PJ), by improvements in automobile fuel-efficiency (3.9 million toe or 165 PJ), by a decline in the average energy demand of housing (1.7 million toe or 70 PJ), and by a reduction in the per unit consumption of the service sector (1.6 million toe or 65 PJ). Each of these phenomena will be discussed in greater detail below.

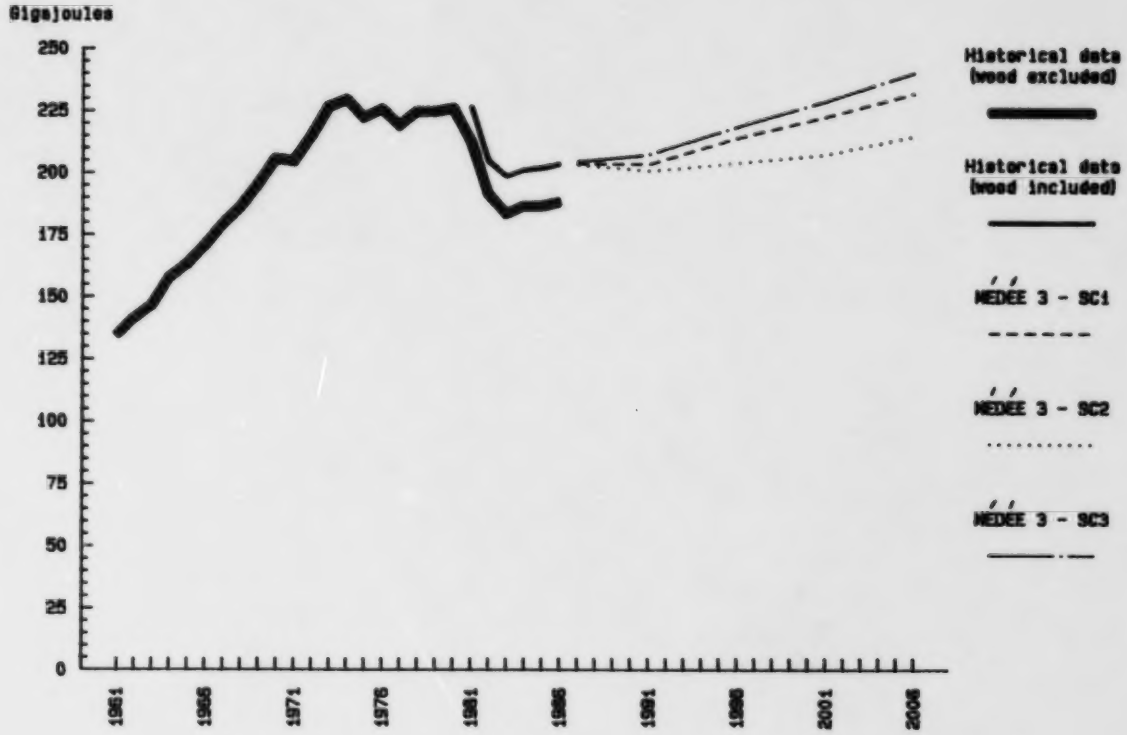
Graph 9 - Total energy consumption by thousand dollars of output (in gigajoules) 1961-2006



II - Energy demand according to energy form

By analyzing the results obtained in the three scenarios, we were able to draw a number of important conclusions on the markets for each form of energy. Before examining these results, we should emphasize several general conclusions on the very development of the energy balance in Québec.

Graph 10 - Total energy consumption per inhabitant (in gigajoules) 1961-2006



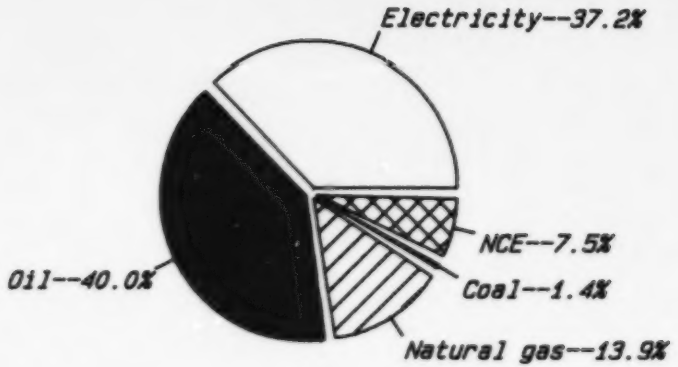
A) The energy balance in Québec

A preliminary analysis of the results leads to the following conclusions on the breakdown of Québec's energy balance according to energy form:

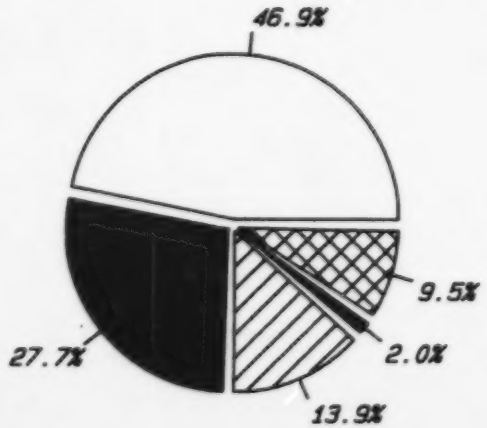
- First, regardless of the scenario studied, electricity will become the main form of energy used in Québec over the next 10 years. This forecast might be fulfilled before 1991 (scenarios 1 and 2), or between 1991 and 1996 (scenario 3). By putting an end to a situation that has prevailed since 1951, the replacement of oil by electricity, as the predominant energy form on the Québec market, will be the logical outcome of a remarkable trend that began in the early 1970s.

Graph 11 - Demand by energy form
(in percent)
1986-2006

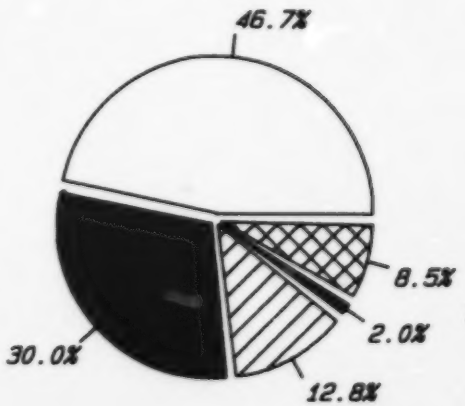
1986



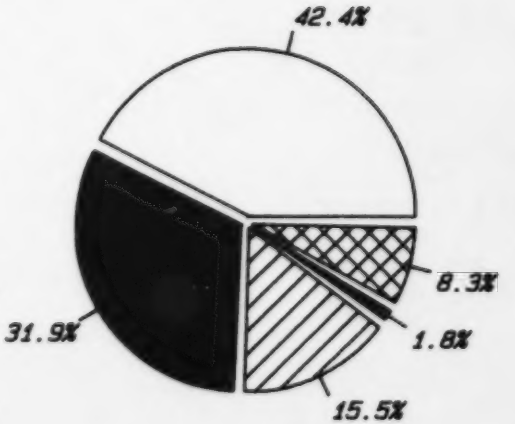
2006



MÉDÉE 3 - SC1



MÉDÉE 3 - SC2



MÉDÉE 3 - SC3

NCE: non-conventional energy

- Secondly, the margin between the results obtained in each of the three scenarios is narrower in the case of oil and electricity consumption than it is for natural gas. For example, the highest forecast for electricity consumption for 2006 (scenario 1) exceeds the lowest forecast (scenario 2) by 11%. Although the difference is more marked in the case of oil (a gap of nearly 22% between scenarios 2 and 3), it is still relatively small given the forecast horizon studied.

These results can be explained by several factors:

- Electricity consumption, like oil consumption, is largely dependent on captive markets, which are relatively unaffected by variations in the comparative prices of the various energy forms and even, in some cases, by changes in economic growth. This statement applies, for example, to household appliances, in the case of electricity, and to the automobile market, in the case of oil.

- In all three scenarios, similar growth assumptions were adopted for the productive capacity of one of electricity's major captive markets - the aluminum industry.

- In the case of noncaptive uses sensitive to the competitive position of energy forms (heating), the crude oil price variations simulated in the three scenarios did not allow petroleum products to maintain or recover a significant share of existing markets.

- Natural gas consumption, on the other hand, seems to be much more unstable than that of oil and electricity; in particular, it is especially sensitive to the different assumptions adopted in the three scenarios. There is a very wide margin between the results obtained for this product. The maximum consumption level for the year 2006 (scenario 3) is nearly 40% higher than the minimum level obtained (scenario 2). The gap is even wider for certain intervening years.

This phenomenon is directly linked to the relatively limited role played by captive markets in natural gas consumption, compared with the situation that prevails in the case of oil and electricity. As will be seen below, most gas markets are very competitive, and overall gas consumption is therefore very sensitive, and, in fact, more so than any other energy form, to differences in energy prices and to the competition they entail.

- A fourth, fairly general conclusion, can be drawn with respect to non-conventional forms of energy. It can be noted that, for the period studied, the share of non-conventional energy forms in Québec's energy balance does not change significantly in the three scenarios selected. According to our estimates, their share, which accounted for 7.5% in 1986, would

probably increase to 9.5% (scenario 1), 8.5% (scenario 2), or 8.3% (scenario 3) by 2006. This cannot be considered a major break with the current situation.

B) Markets for the various energy forms

a) Electricity consumption

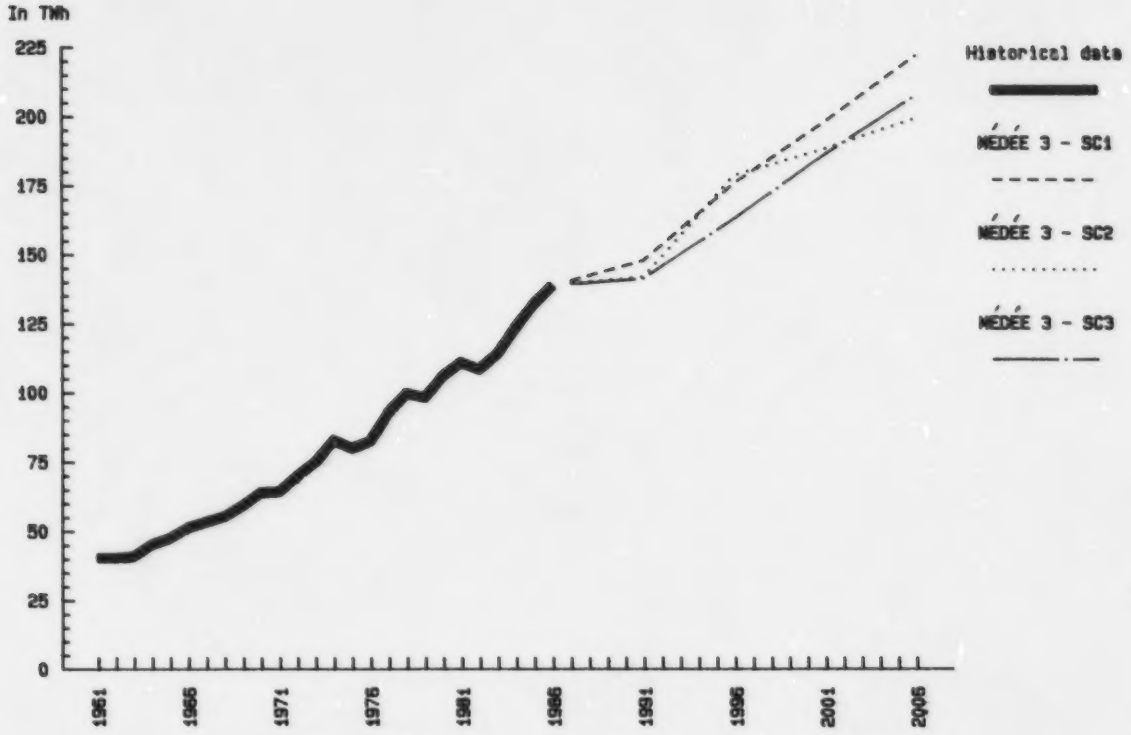
The results we obtained in the three scenarios suggest that electricity demand will continue to grow in Québec over the next 20 years. For the period as a whole, the average annual growth rate would amount to 2.4% in scenario 1, 1.8% in scenario 2, and 2.0% in scenario 3. This constitutes a slowdown in comparison with the past decade; electricity consumption in Québec rose by an average of 5.3% per year between 1976 and 1986. In fact, however, the slowdown is less significant than it appears: if surplus electricity sales are not taken into account, electricity consumption in Québec would increase by an average of 2.9% per year (scenario 1), 2.3% (scenario 2), and 2.6% (scenario 3), compared to an average annual growth rate of 4.3% between 1976 and 1986.

It should also be noted that, according to the three scenarios, the growth rate of electricity demand will probably remain higher than that of total energy demand. As electricity becomes the predominant form of energy used in Québec, its share in the energy balance is likely to increase from its 1986 level of 37% to 47% (scenarios 1 and 2) or 42% (scenario 3) by 2006. By the end of the period, electricity consumption in Québec would reach 222 TWh in scenario 1, 200 TWh in scenario 2, and 208 TWh in scenario 3; these levels are 83 TWh, 60 TWh and 69 TWh higher respectively than the level recorded in 1986.

These results merit a few comments:

- We should first emphasize that the continued penetration of electricity on the Québec market, as observed in the three scenarios, is remarkable for two reasons. For one thing, electricity already accounts for a very large share of the energy balance in Québec. In fact, Québec is one of today's industrialized societies which relies most on electricity. Secondly, this continued penetration is observed in all three scenarios which, as seen above, are based on different assumptions for economic growth and changes in the price of international crude oil. Despite the tremendous upswing observed over the past decade (the share of electricity in Québec's energy balance rose from 20% to 37% between 1976 and 1986), there still seems to be considerable room for electricity consumption growth on the domestic market.

Graph 12 - Total electricity consumption in Québec
(in TWh)
1961-2006



- If we examine the distribution of electricity demand growth among the various consumption sectors for the years 1986 to 2006 (see Table 4), it can be noted that the contribution each sector will make during the period as a whole corresponds approximately to its respective, relative importance in 1986. The residential sector would account for 25%, 33% and 30% of the additional electricity demand in scenarios 1, 2 and 3 respectively; this sector accounted for 31% of total electricity consumption in 1986. The share of the industrial sector in the additional electricity demand would amount to 59% in scenario 1, 52% in scenario 2 and 56% in scenario 3; its relative share in electricity consumption was 51% in 1986.

- As can be seen, the results obtained in the three scenarios with regard to the growth of residential electricity consumption are relatively similar in absolute value over the period studied. From 1986 to 2006, electricity consumption by the residential sector would increase by 20.7 TWh in scenario 1, 20.3 TWh in scenario 2, and 20.8 TWh in scenario 3. Overall, the growth in residential electricity demand seems to be relatively unaffected by the economic growth and oil price assumptions tested. Compensatory forces are probably at work. For example, in scenario 1, the repercussions of strong economic growth and high oil prices on the penetration of electricity seem to be offset by the impact of these factors on the introduction of heat pumps, which substantially reduce heating-related electricity needs.

Table 4 - Sources of variation in total electricity demand (in TWh) 1986-2006

	1986	2006 less 1986		
		SC1	SC2	SC3
RESIDENTIAL	42.9	20.7	20.3	20.8
. Space heating	19.2	12.4	12.7	12.7
. Water heating	7.7	4.0	4.0	3.6
. Household appliances	15.2	3.3	2.9	3.3
. Other	0.8	1.1	0.7	1.2
COMMERCIAL	24.7	12.9	8.5	8.8
TRANSPORTATION	0.3	0.7	0.7	0.7
INDUSTRIAL	70.8	49.1	31.3	38.6
. Captive uses				
- Aluminum	18.2	18.0	18.0	14.3
- Pulp and paper	15.6	10.8	5.8	10.8
- Other industries	25.0	9.6	3.4	9.6
. Noncaptive uses				
- Heating	11.9	0.8	-1.9	-4.0
.Electrotechnologies	0.1	9.9	6.0	7.9
TOTAL	138.7	83.4	60.8	68.9

- Our results for the industrial sector vary to a larger extent from one scenario to another than those related to residential energy consumption. Over the period 1986-2006, industrial electricity consumption would increase by 49.1 TWh in scenario 1, 31.3 TWh in scenario 2, and 38.6 TWh in scenario 3. The gap between scenarios 1 and 2 means that the economic growth assumptions tested in the two scenarios differ more widely with respect to the activity of the industrial sector, despite the fact that identical assumptions were adopted in both cases for the productive capacity of aluminum plants. The margin between scenarios 1 and 3 can be explained by the impact of lower oil prices on the heating market and aluminum plants.

Before concluding this section, we should discuss the results obtained with regard to electricity demand during the sensitivity analysis of Hydro-Québec's financial criteria. As specified above,[1] additional simulations (scenarios 1.14 and 2.14) were performed in the case of scenarios 1 (strong growth) and 2 (slow growth) so as to test the sensitivity of electricity demand and Québec's energy balance to certain financial constraints imposed on Hydro-Québec. During the simulations, this Government corporation had to record a minimum return of 14% on equity. This constraint was likely to modify the results of scenarios 1 and 2, since it increased the rates imposed by Hydro-Québec and, therefore, reduced the competitive position of electricity on Québec's energy market.

Our results demonstrate that such constraints would, in effect, reduce the growth in electricity demand and limit the penetration of this energy form in Québec's energy balance. The ensuing slowdown in consumption would, however, be relatively limited; it is more pronounced in the sensitivity analysis of scenario 2 than in the simulation performed for scenario 1. Our results suggest that, in the event of such constraints, electricity consumption by the year 2001 would be 3.1% lower than the reference demand in scenario 1 (6 TWh less) and 5.1% lower than that in scenario 2 (9 TWh less). According to the two simulations, the decline in consumption would probably be less pronounced by 2006; similar results were obtained in both alternative scenarios (a decrease of 2.8% or 6 TWh in scenario 1 and 2.9% or 6 TWh in scenario 2).

The relatively limited effect - on electricity demand - of the financial constraints imposed on Hydro-Québec can be largely attributed to three factors. First, the higher electricity tariffs required as a result of higher rates of return would be partly cancelled out by the reduced investment needs entailed by lower electricity demand. Secondly, these rate increases would come into effect mainly after 1991, or at a time when electricity

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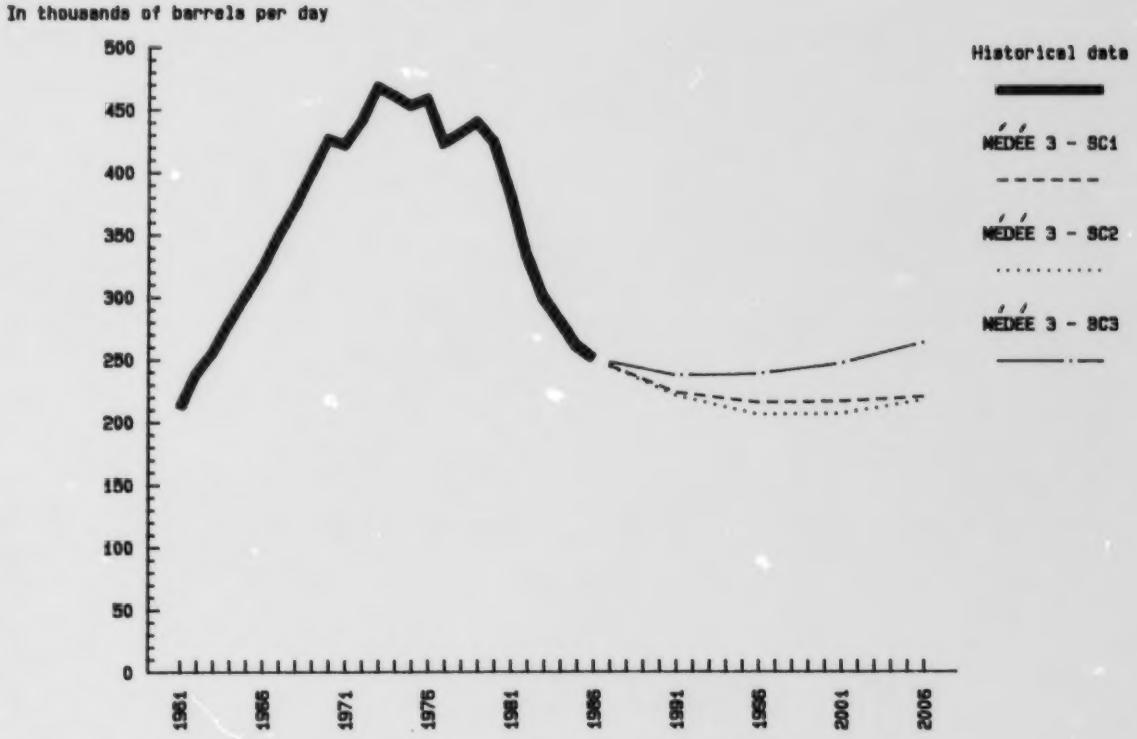
(1) See page 6.

will already have replaced oil in the residential sector. Thirdly, electricity consumption levels are, in any case, partly determined by captive uses, which are relatively unaffected by changes in the competitive position of electricity.

b) Oil consumption

Similar results were obtained in all three scenarios with regard to the pattern of oil consumption in Québec. It can be noted that, in all three cases, there would be a further decline in consumption. This decrease would last until 1996 in scenarios 1 and 2 and 1991 in scenario 3. This slowdown should be followed by a slight recovery, which would be more pronounced in scenario 3 than in scenarios 1 and 2. Our results suggest that oil consumption will grow at an average annual rate of -0.6% (scenario 1), -0.8% (scenario 2), or 0.2% (scenario 3) for the period 1986-2006

Graph 13 - Total oil consumption in Québec (in thousands of barrels per day) 1961-2006



as a whole. Accordingly, by the end of the period, the Québec consumption of petroleum energy products (therefore excluding such products as asphalt and petrochemical bases) would reach 221 000 barrels per day (scenario 1), 218 000 barrels per day (scenario 2), or 264 000 barrels per day (scenario 3). These levels are, respectively, 12% and 13% lower and 5% higher than the consumption level recorded in 1986 (251 000 barrels per day).

Obviously, this decline in or stabilization of oil consumption will entail a further reduction in the share of oil in Québec's energy balance: our results suggest that this share, which amounted to 40% in 1986, would drop to 28% (scenario 1), 30% (scenario 2) or 32% (scenario 3).

However, it can be noted in the three scenarios studied that, even if the importance of oil on the Québec energy market continues to decline, this phenomenon could hardly be compared with the sharp downturn in oil consumption recorded between 1976 and 1986. Over the past decade, the share of oil in the overall energy balance dropped from 68% to 40%, while consumption decreased by 48% in absolute value. This gradual slowdown in the rate of decrease can be easily explained. The replacement of oil by natural gas and electricity for heating purposes (especially in the residential sector) should be almost completed by the end of the next decade, and there should be no further significant energy savings in the heating of old buildings. Improvements in the average fuel efficiency of the automobile stock should also slow down considerably after 1991. From 1996 onward, transportation energy demand will be largely responsible for the renewed increase in oil consumption.

A comparison of scenarios 1 and 2 reveals that there is a very narrow margin between the results for the year 2006: a difference of less than 2% can be observed in the oil consumption levels of scenarios 1 and 2 (221 000 barrels per day relative to 218 000 barrels per day). In scenario 2, the slow economic growth assumption is partly offset by the impact of the slower oil price increase on demand.

On the other hand, in scenarios 1 and 3, where we used different oil price assumptions in conjunction with identical assumptions about economic growth, it can be noted that a drop in the price of international crude oil would have a significant effect on oil consumption. The consumption level obtained in scenario 3 (low oil price) for the year 2006 is almost 20% higher than that obtained in scenario 1 (high oil price): 264 000 barrels per day compared to 221 000 barrels per day. However, a certain number of factors would prevent the margin from being even wider. The decline in oil demand is partly related to investments which cannot be called into question in the short term. This is the case, for

example, of thermal insulation in the residential sector or improvements in automobile fuel efficiency. In addition, in scenario 3, it seems that the decline in oil prices will not be pronounced enough or, above all, prolonged enough to entail a major increase in the use of oil on certain markets, such as those related to heating.

A second phenomenon should also be pointed out: in all three scenarios, oil consumption would be almost totally relegated to the transportation sector. In 1986, this sector accounted for 67% of total oil consumption. According to our estimates, this share would increase to 81% in scenario 1, 84% in scenario 2, and 80% in scenario 3 by 2006. This phenomenon will affect the relative importance of each petroleum product. In 1986, gasoline, diesel fuel and jet fuels accounted for 62% of petroleum product consumption. We estimate that, by 2006, they would account for 73% of oil consumption in scenario 1, 77% in scenario 2, and 73% in scenario 3.

It can be noted that, even in the low price case (scenario 3), oil would virtually disappear from the residential sector by 2006 and that it would play only a very limited role in the industrial and commercial sectors. As can be seen in Table 5, the transportation sector alone would account for oil consumption growth throughout the period studied.

Table 5 - Sources of variation in total oil demand (in thousands of barrels per day) 1986-2006

	1986	2006 less 1986		
		SC1	SC2	SC3
RESIDENTIAL	36.7	-30.0	-31.3	-29.9
COMMERCIAL	14.5	-6.0	-6.6	-4.6
TRANSPORTATION	172.4	8.4	13.3	43.3
. Road	138.2	-1.0	6.6	30.4
. Rail	5.1	1.1	0.6	1.1
. Air	15.5	2.9	2.2	5.1
. Marine	13.6	5.4	3.9	6.5
INDUSTRIAL	27.4	-2.7	-8.3	4.2
TOTAL	250.9	-30.2	-32.8	13.1

c) Natural gas consumption

In the three scenarios studied, the growth in natural gas demand would stop around 1991. Subsequently, the share of natural gas in the total energy balance would either remain at the same level (scenarios 1 and 3) or decline (scenario 2), so that by the end of the period, the share of natural gas in the energy balance would be either lower than (scenario 2), equivalent to (scenario 1), or slightly higher than (scenario 3) the level recorded in 1986. For the period 1986-2006 as a whole, the average annual growth rate of natural gas consumption would be 1.2% in scenario 1, 0.3% in scenario 2 and 1.9% in scenario 3. Overall, natural gas consumption in Québec would account for 224 billion cubic feet (scenario 1), 187 billion cubic feet (scenario 2), or 259 billion cubic feet (scenario 3) by the end of the period. In other words, relative to its 1986 level of 14%, the share of natural gas in Québec's energy balance should either remain unchanged in scenario 1 (14%), drop to 13% in scenario 2, or increase to 16% in scenario 3 by 2006.

Graph 14 - Total natural gas consumption in Québec (in billions of cubic feet) 1961-2006

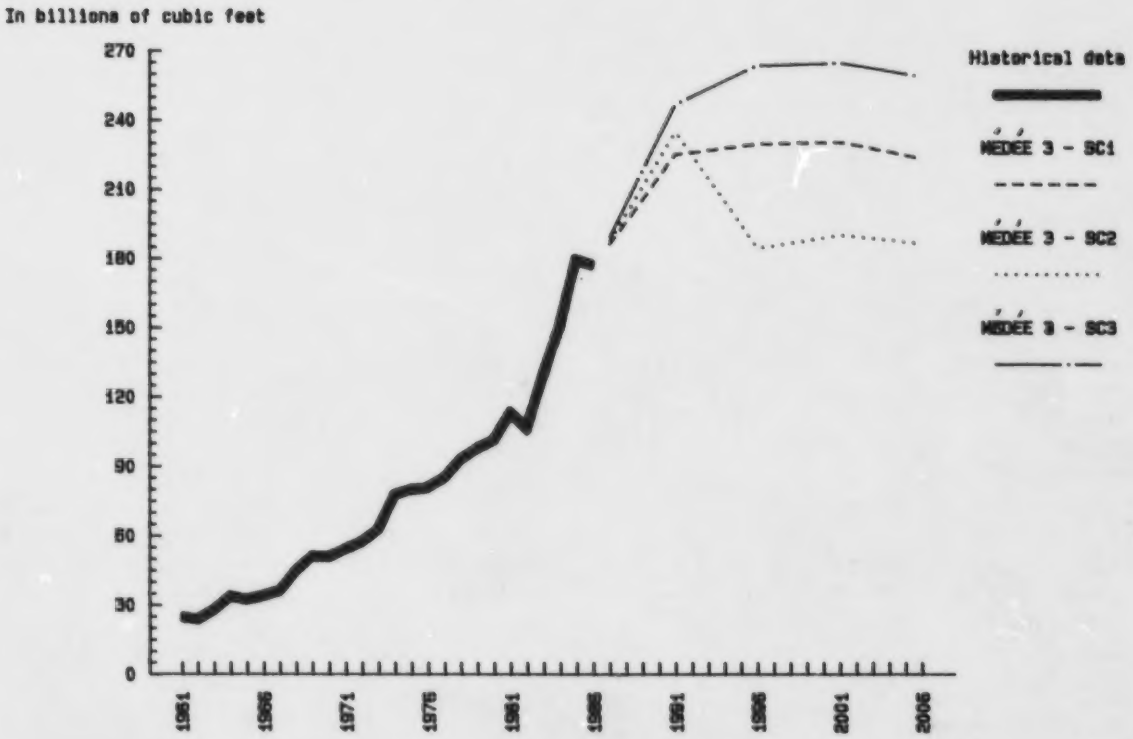


Table 6 - Sources of variation in total natural gas demand (in billions of cubic feet) 1986-2006

	1986	2006 less 1986		
		SC1	SC2	SC3
RESIDENTIAL	26.6	3.8	0.9	7.8
COMMERCIAL	38.3	9.8	-1.8	29.8
TRANSPORTATION	0.0	11.4	5.4	6.4
INDUSTRIAL	112.5	21.1	4.7	37.5
TOTAL	177.4	46.1	9.1	81.5

A rapid examination of the results presented above highlights a phenomenon already mentioned in this document: in contrast to what was observed in the case of oil and electricity, there are wide relative differences between scenarios in the results obtained for natural gas. In addition, the results also vary noticeably within a given scenario, depending on the subperiod analyzed. These results underscore the relative instability of natural gas consumption and its high sensitivity to the assumptions adopted for economic growth and crude oil prices.

This instability is confirmed by the analyses measuring the sensitivity of natural gas consumption to certain constraints imposed on Hydro-Québec's rates of return on equity. As seen above, these analyses were meant to determine the impact of these constraints within the framework of scenarios 1 and 2. As specified above, they had a limited effect on electricity demand, as estimated for the end of the period.[1] In absolute value, they had an equivalent impact on natural gas demand; however, when considered in relation to total gas demand, their relative impact appears to be greater. The results of simulations 1.14 and 2.14 suggest that, if such financial constraints were actually imposed on Hydro-Québec, natural gas consumption would exceed the consumption levels obtained in the reference scenario by 8.8% and 9.5% respectively by 2006. In other words, the relative impact of these constraints would be three times greater in the case of gas demand than in that of electricity demand.

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(1) See page 41.

The instability of gas markets and their sensitivity to the various assumptions tested should be studied in greater depth.

- An analysis of the results by consumption sector reveals that, although this instability is common to all sectors, it is especially pronounced in the commercial sector.

- Our results suggest that, by 2006, natural gas consumption by the residential sector should reach 30.4 billion cubic feet (scenario 1), 27.5 billion cubic feet (scenario 2), or 34.4 billion cubic feet (scenario 3); in 1986, natural gas consumption was equivalent to 26.6 billion cubic feet. The difference between the highest and the lowest estimates is slightly less than 25%. It is a significant margin, comparable to the one in the industrial sector, but much smaller than that observed in the commercial sector.

- In the industrial sector, there is a margin of 28%, or 33 billion cubic feet, between the highest (scenario 3) and the lowest estimates (scenario 2).

- In the commercial sector, the difference amounts to almost 90%. By the end of the period, commercial gas consumption would reach 48.1 billion cubic feet in scenario 1, 36.5 billion cubic feet in scenario 2, or 68.1 billion cubic feet in scenario 3.

Our results seem to indicate, therefore, that natural gas consumption in Québec is very sensitive, not only to changes in economic growth, but also to fluctuations in the price of crude oil, and that this phenomenon is common to all consumption sectors. It is especially obvious in the commercial sector.

- Some of the factors responsible for this situation were described above. Contrary to oil and electricity, natural gas does not have large captive markets. It is sold on highly competitive ones, where it comes into competition with certain petroleum products or electricity. Insofar as the various assumptions tested in the scenarios and sensitivity analyses (for economic growth, crude oil prices and the profitability of Hydro-Québec) had an effect on the competitive position of the various energy forms and, in particular, on electricity rates, the results obtained reflect no more than the impact of change, for the better or for the worse, in the competitive position of gas on these markets.

Our results also bring out the direct impact that changes in Hydro-Québec's installations program would have on natural gas consumption, insofar as these modifications were reflected in the rates imposed by this Government corporation. Incidentally, some of the differences noted in the natural gas consumption results for the commercial sector (scenario 1 compared to scenario 2) can

be attributed to the implicit strategy employed in elaborating the scenarios. As specified above, we assumed that, within a given price situation, gas distributors would implement a policy aimed, above all, at protecting their most important market - namely, the industrial market - since the commercial sector can, to a certain extent, serve as a stabilizing factor against changes in the competitive position of the various energy forms[1].

We should emphasize one last point with respect to the growth of natural gas consumption in Québec. In all three scenarios, natural gas appears for the first time on the Québec fuel market. According to our results, gas consumption for transportation purposes would probably reach 11.4 billion cubic feet (scenario 1), 5.4 billion cubic feet (scenario 2), or 6.4 billion cubic feet (scenario 3) by 2006. Since gas consumption was still negligible in the transportation sector in 1986, these gains reflect the small but not unimportant contribution that natural gas is likely to make toward meeting the needs of this sector. Natural gas would account for between 1.4% (scenarios 2 and 3) and 2.9% (scenario 1) of the transportation market by 2006. It should be specified that the gas product referred to here is natural gas for vehicles (NGV).

d) Non-conventional energy consumption

We obtained relatively similar results in all three scenarios for the development of non-conventional energy forms. Non-conventional energy consumption amounted to 2.4 million toe (100 PJ) in 1986. By 2006, it would reach 3.9 million toe (161 PJ) in scenario 1, 3.1 million toe (131 PJ) in scenario 2, and 3.5 million toe (147 PJ) in scenario 3. In all three scenarios, consumption growth would be sustained; however, it should be more rapid in the first subperiod (1986-1996) than in the second (1996-2006). Our results suggest that, overall, non-conventional energy demand in Québec would increase by an average annual rate of 2.4% (scenario 1), 1.4% (scenario 2) or 1.9% (scenario 3). In all three scenarios, this growth would be slightly stronger than that for total energy demand. The share of non-conventional energy forms in Québec's energy balance would reach 9.5% in scenario 1, 8.5% in scenario 2, and 8.3% in scenario 3; it accounted for 7.5% in 1986.

Three points should be emphasized with regard to non-conventional energy forms.

- First, in the scenarios studied, forest and urban biomass would continue to account for almost the total share of non-conventional energy forms used in Québec. Our results do not suggest that

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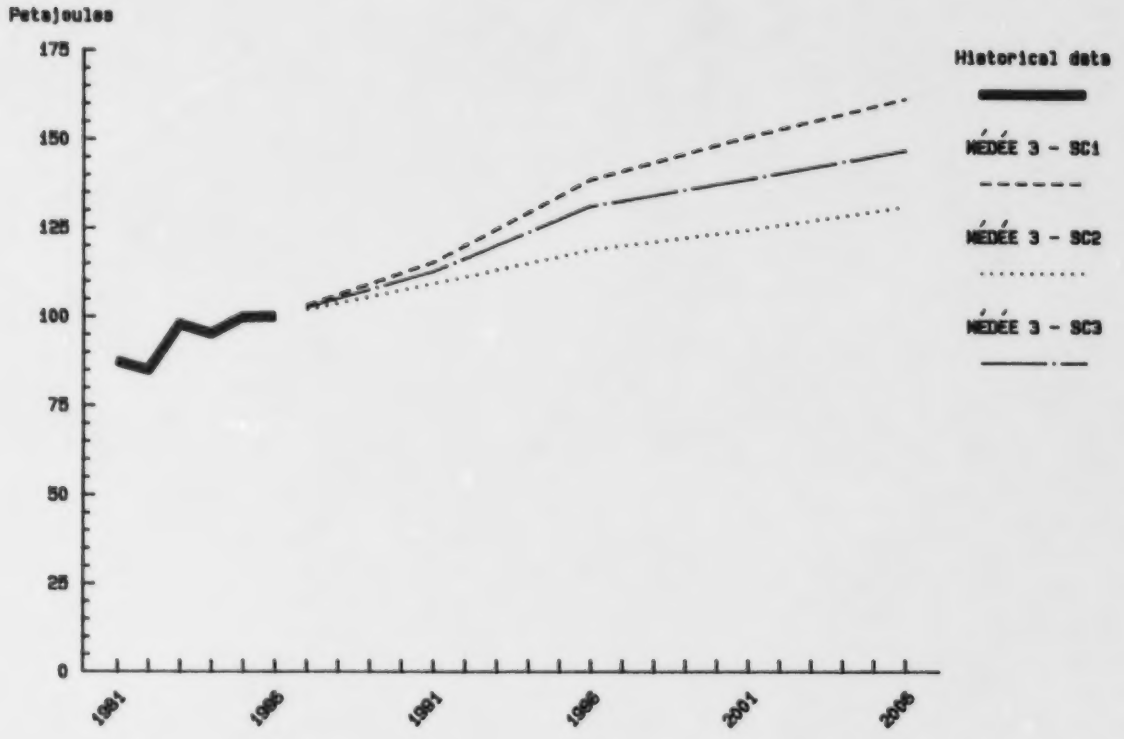
(1) See pages 24 and 25.

Graph 15 - Total non-conventional energy consumption in Québec (in petajoules) 1981-2006



other non-conventional sources of energy (wind and solar power, etc.) will make significant inroads on the market during the study period.

- Secondly, non-conventional energy forms are used primarily in two clearly identified markets, namely, those that cater to the heating needs of the industrial and residential sectors. In 1986, these two sectors accounted respectively for one third and two thirds of Québec's non-conventional energy consumption. In all three scenarios, the situation should remain practically unchanged in 2006: the share of the residential sector in total non-conventional energy demand would range from 25% (scenario 1) to 30% (scenario 2), while the share of the industrial sector would vary between 60% (scenario 1) and 62% (scenario 2).

It can therefore be noted that the general pattern of non-conventional energy consumption and the market behavior of non-conventional energy forms are not very sensitive to the economic growth

and crude oil price assumptions tested. The relative peaking of the share of non-conventional energy forms in the residential and industrial sectors can be explained by factors specific to these two markets: in the residential sector, the penetration potential of forest biomass for heating purposes is limited to single-family homes located outside metropolitan areas. In the industrial sector, this energy form is mainly relegated to the pulp and paper sector and its use is dependent on the availability of forest resources and, therefore, of usable wastes.

- Thirdly, non-conventional energy forms should begin to play a certain role in the transportation sector. This constitutes a break with the current situation for, like natural gas, non-conventional energy forms are virtually absent from the fuel market at the present time. According to the scenarios studied, certain non-conventional energy sources (methanol and ethanol) should make some inroads. This penetration should be more pronounced in scenario 1, which is based on the highest crude oil price. In this scenario (rapid oil price increase), non-conventional energy forms would account for 6% of the transportation market by 2006, as compared to 3% in scenario 2 (moderate increase) or 2% in scenario 3 (limited increase).

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CHAPTER 4. RESULTS: DEMAND BY SECTOR OF CONSUMPTION

The results obtained from the simulations have brought out several important features in the demand for the various energy forms over the next 20 years. An analysis of the results by consumption sector (residential, commercial, industrial, transportation) has provided us with a better understanding of the way in which energy consumption in Québec should change between now and 2006.

I - The relative weight of each consumption sector

Graphs 16 to 19 show changes in energy demand for each consumption sector: the changes include both the observed data for the period 1961-1986 and the results of the three scenarios analyzed for the period 1986-2006. By studying the graphs and all available data, we are able to compare energy demand trends in each of the four main consumption sectors. Several interesting phenomena can immediately be observed.

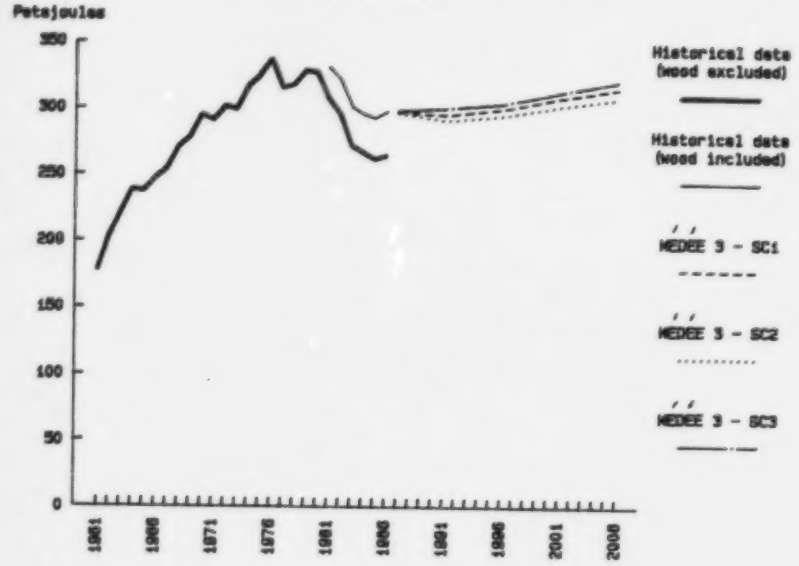
No matter which scenario is studied, a certain degree of inertia can be seen in the overall distribution of energy demand by sector. In 1986, the residential, commercial, industrial, and transportation sectors accounted respectively for 22%, 12%, 39% and 27% of total energy demand. By 2006, this distribution should not vary by more than six percentage points in any of the scenarios or sectors studied. This phenomenon can be explained by the very nature of an exercise aimed at comparing consumption sectors, for, by definition, it takes into account, only indirectly, factors related to the substitution of one energy form for another. In the light of the situation prior to 1986, the changes observed in the relative importance of each consumption sector should be considered significant for the period studied.

Certain trends stand out for the period as a whole when we analyze the respective weight of each consumption sector. For example, in all three scenarios, the relative share of the industrial sector should increase, while those of the commercial and transportation sectors should fluctuate within narrow margins. On the other hand, the relative share of the residential sector in total energy consumption should decline steadily.

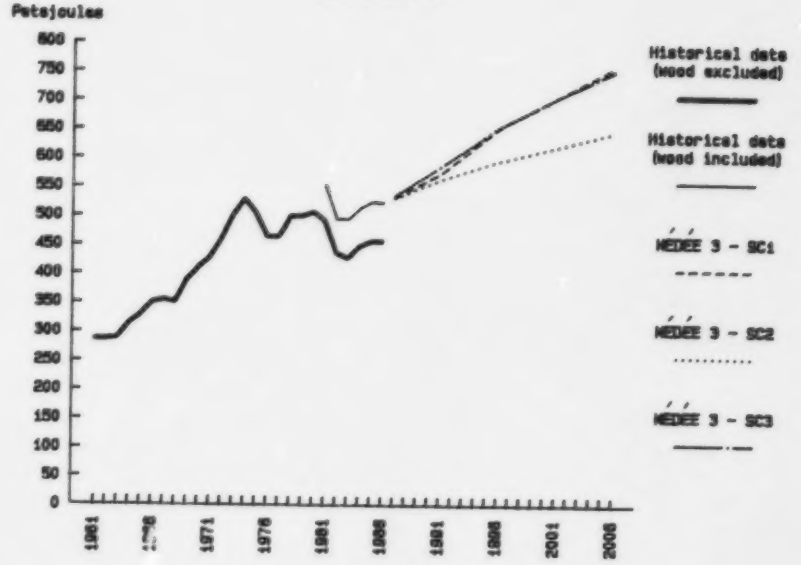
- The relative growth of the industrial sector is a fairly recent phenomenon, which seems to have begun in the early 1980s. On the basis of the scenarios studied, the share of the industrial sector in total energy consumption would reach 45% (scenario 1), 42% (scenario 2) or 43% (scenario 3) by 2006, as compared to 39% in 1986.

Graphs 16, 17, 18 and 19 - Energy consumption by sector (in petajoules) 1961-2006

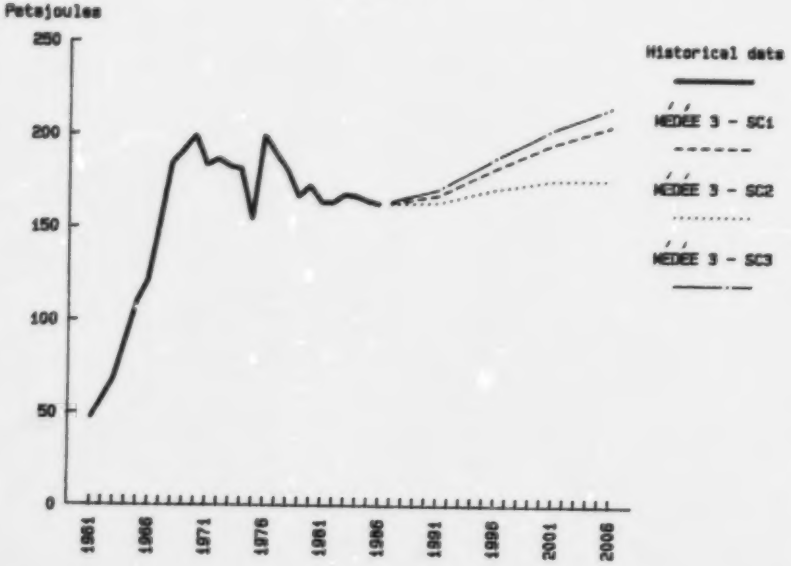
Residential



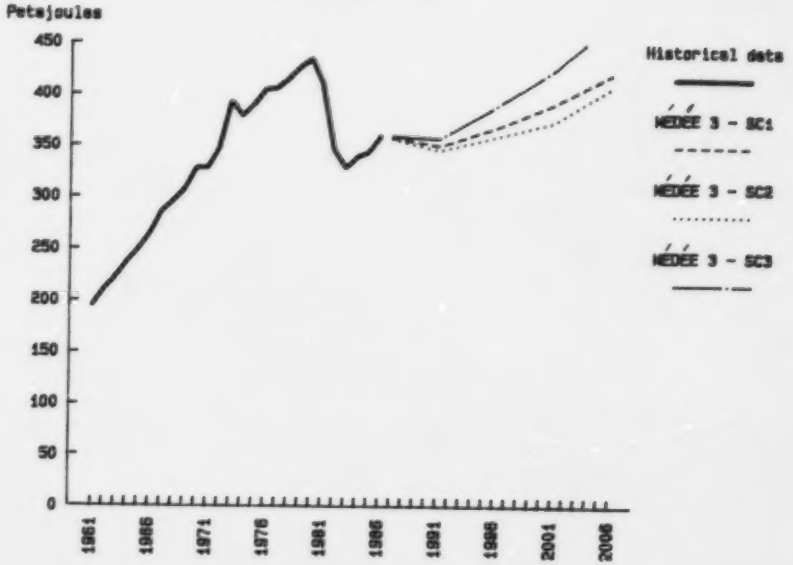
Industrial



Commercial



Transportation



In practice, the additional energy demand in the industrial sector would account for 63% (scenario 1), 58% (scenario 2) or 53% (scenario 3) of the growth in total energy demand for the period 1986-2006, or for proportionately more than the share of this sector in energy consumption in 1986.

It can also be noted that, in absolute value, industrial energy consumption seems to be virtually unaffected by differences in the price of crude oil: in 2006, there will be a difference of less than 1% between scenarios 1 and 3. As can be expected, a comparison of scenarios 1 and 2 reveals that industrial energy demand is sensitive to the alternative economic growth assumptions. In 2006, the industrial energy consumption in scenario 1 should be 17% higher than the industrial energy demand in scenario 2; the difference in GDP for the industrial sector would amount to 32%.

- Our second observation concerns the commercial and transportation sectors, whose relative weights vary little throughout the period studied in all three scenarios. By 2006, the relative shares of each of these sectors in energy consumption would be 12% and 25% in scenario 1, 11% and 26% in scenario 2, or 12% and 27% in scenario 3; their relative shares were 12% and 27% in 1986.

- In all three scenarios, commercial energy demand would increase at almost the same rate as total energy demand. Although it would be primarily affected by differences in economic growth (margin of 17% between scenarios 1 and 2 for 2006), it would also be sensitive to changes in the price of crude oil (margin of 5% between scenarios 1 and 3 by the end of the period).

- The relative stabilization of the weight of the transportation sector in total energy demand confirms the turnaround observed since 1984. Between 1980 and 1983, the share of the transportation sector in total energy consumption dropped sharply, from 29% to 25%. In absolute value, transportation energy consumption declined by 25% over the same period. From 1984 onward, there was some recovery in transportation energy demand. As can be seen, this trend should continue, to varying degrees, in all three scenarios. This renewed growth in energy demand should be especially marked in scenario 3 (low oil price scenario). The different oil price assumptions adopted in scenarios 1 and 3 should create a margin of 12% by the end of the period. The difference between the crude oil price assumptions used in scenarios 1 and 2 should be largely offset by the impact of the alternative economic growth assumptions; the gap observed by the end of the period would amount to only 3%.

- A third, very interesting observation concerns the residential sector. In all three scenarios, one can note a limited, but sustained, decline in the relative weight of this sector in

total energy consumption. The share of the residential sector in total energy consumption would drop to 19% in scenario 1, 20% in scenario 2, or 18% in scenario 3 by the end of the period; it accounted for 22% in 1986. We will present explanations for this phenomenon below. It can also be noted that there is very little difference, in absolute value, between the results obtained for the residential sector. In 2006, the gap between the maximum (scenario 3) and minimum (scenario 2) consumption levels should barely exceed 4%. It seems, therefore, that energy demand in the residential sector will be just as unaffected by varying rates of economic growth as it will be by the different oil price increases assumed in each scenario.

II - The residential sector

We have just emphasized that there is a very narrow margin between the results on residential energy consumption. It can also be noted that there is not much difference in the rate of growth of demand within the period studied. Our results suggest that the energy demand in the residential sector would increase at an average annual rate of 0.3% (scenario 1), 0.2% (scenario 2) or 4% (scenario 3). This moderate growth contrasts with the downturn observed between 1976 and 1986 (-2.1% per year) and the strong growth of the 1960s and 1970s (4.4% per year from 1961 to 1976). By 2006, in absolute value, residential energy consumption would reach 7.5 million toe (316 PJ) in scenario 1, 7.4 million toe (308 PJ) in scenario 2 and 7.7. million toe (321 PJ) in scenario 3. These consumption levels are 3% to 8% higher than those recorded in 1986.

. The narrow margin between the results obtained in the three scenarios is truly remarkable. Despite the length of the period covered, the highest results (scenario 3) never exceed the lowest ones (scenario 2) by more than 5%. In other words, in the scenarios studied, residential energy consumption for the period 1986-2006 is relatively unaffected by economic activity rates or by the oil price increase assumptions tested.

Four factors seem to be largely responsible for this phenomenon. In all three scenarios, three of these factors tend to reduce residential energy consumption.

- One such factor, namely, the estimated population growth for the next 20 years, limits the growth of residential energy demand. The number and size of dwellings is directly related to household number and size. In all three scenarios, the marked slowdown in the growth of the number of households has a direct impact on energy needs, and this slowdown differs little from one scenario to the other.[1]

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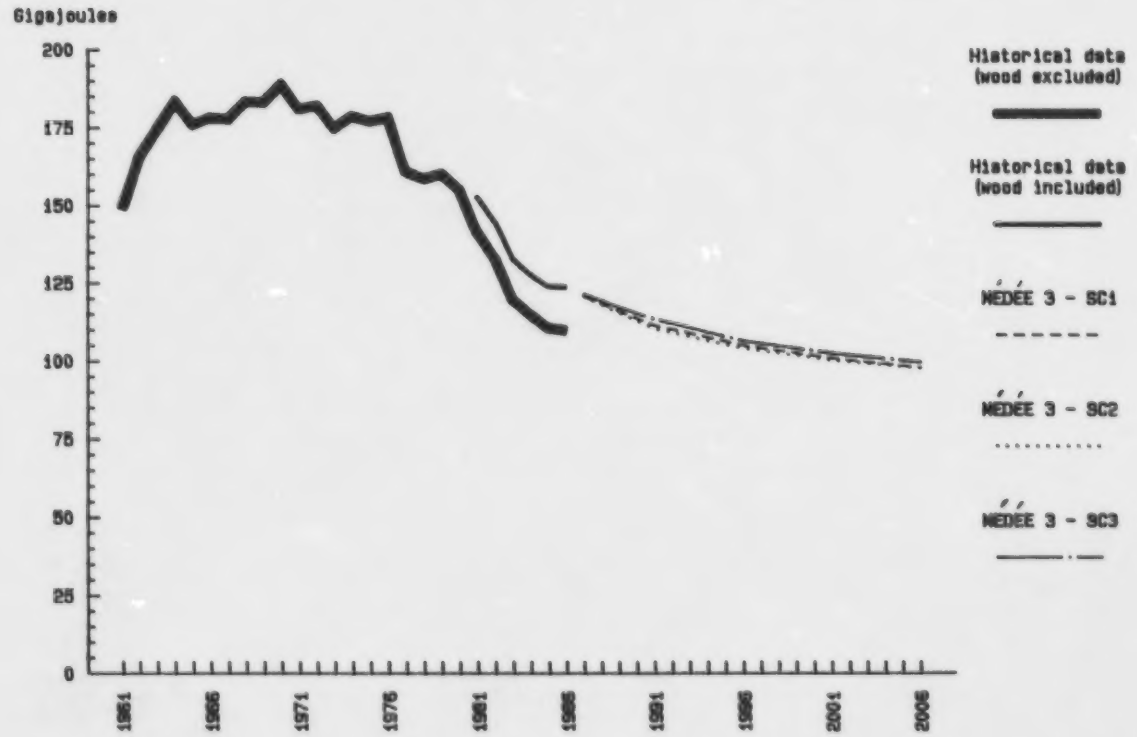
(1) See page 13.

- The second factor concerns the arrival, on the market, of new housing built according to construction norms that substantially reduce the amount of energy needed for space heating. The gradual disappearance of old housing is, therefore, alone sufficient to reduce average energy consumption for heating purposes. This phenomenon is present in all three scenarios.

- In the residential sector, the shift away from one energy form (oil) to another, much more efficient one (electricity) also plays a significant role in limiting demand.

A fourth phenomenon has an opposite effect to these three factors. Over the past decade, improvements in the energy efficiency of old housing have largely contributed to reducing energy consumption by the residential sector. It is estimated that, especially as a result of government information and incentive programs, most of the efforts aimed at insulating old housing have now been made, and that further substantial savings in this regard should not be anticipated in any of the three scenarios.

Graph 20 - Energy consumption per household in the residential sector (in gigajoules) 1961-2006)



. An analysis of the results also reveals that there is a gradual change in the relative importance of energy uses in the residential sector. In this sector, energy serves essentially three purposes: space heating, water heating and the operation of household appliances. In 1986, nearly two thirds (63%) of the energy consumed by the residential sector was used for space heating, compared to slightly less than one fifth (18%) for the operation of household appliances, and around one eighth (12%) for water heating. In all three scenarios, there is a sustained relative decline in the importance of space heating in residential energy consumption. By 2006, space heating should account for 56% of total energy use in this sector; the relative shares of water heating and electrical appliances would increase accordingly.

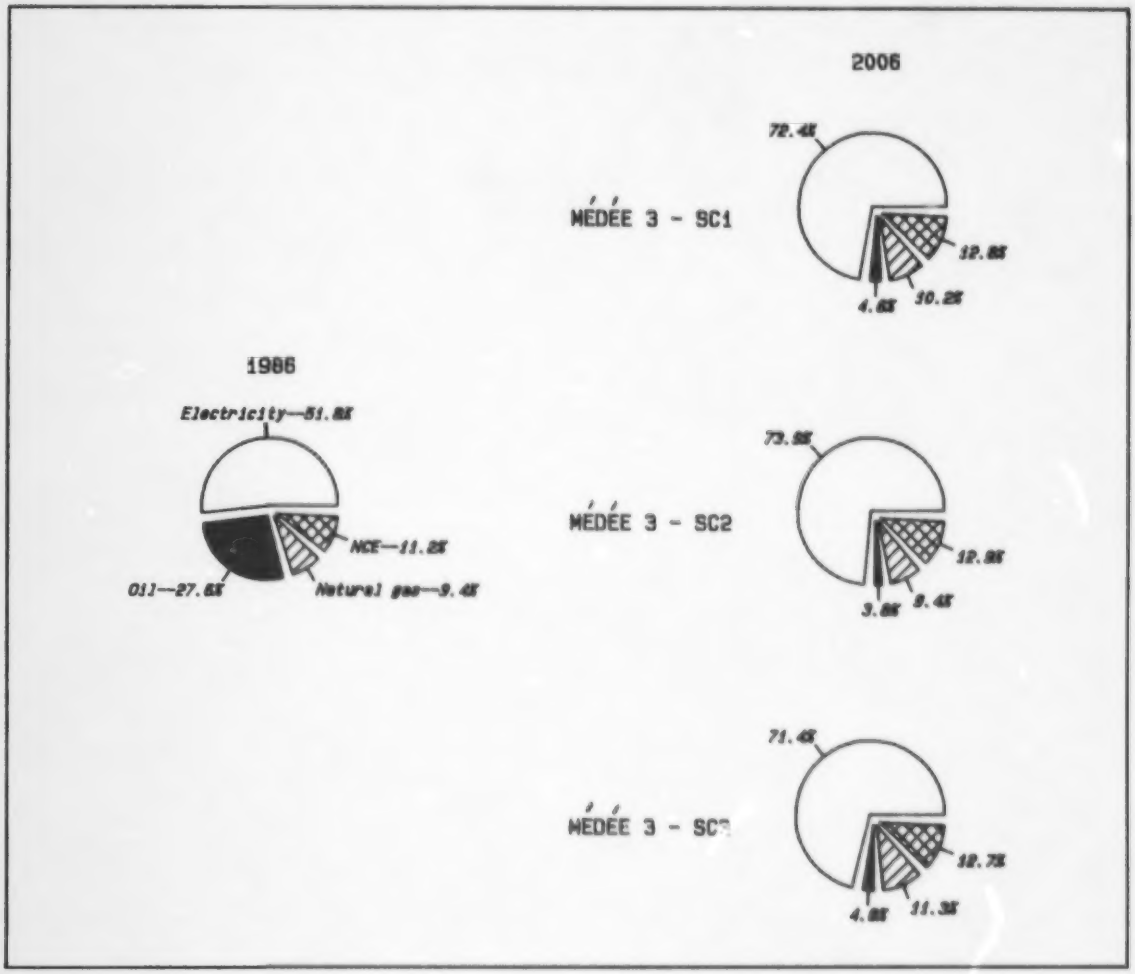
These results confirm that, in the future, we will have to pay special attention to other residential energy uses, particularly to those involving household appliances, if we want to conduct a more in-depth analysis of future trends in residential energy demand.

. Before concluding this section, we should examine the behavior of each energy form on the residential market.

- In all three scenarios, it can be noted that electricity will continue to make inroads on the market at the expense of petroleum products. Our results suggest that the share of electricity in the residential sector, which amounted to 52% in 1986, would increase to 73% (scenario 1), 74% (scenario 2), or 71% (scenario 3). This phenomenon can be observed regardless of whether economic growth is strong or slow, or whether oil prices are high or moderate. One of the basic characteristics of Québec's energy market is the penetration of electricity in the residential sector. This process, which is already well under way, will probably be almost completed by the end of the period studied. Since petroleum products will likely satisfy only 4% to 5% of residential energy requirements by 2006 (composed to 28% in 1986), electricity will therefore have largely exhausted its margin of growth. Actually, the space heating market provides the impetus to this penetration of electricity in the residential sector as old housing is gradually converted to electrical heating and 90% of the new units built are equipped with electrical systems.

- It can also be noted that, in all three scenarios, there is no change in the relative importance of natural gas and non-conventional energy forms. By 2006, natural gas would probably account for 10% (scenario 1), 9% (scenario 2), or 11% (scenario 3) of the residential market, as compared to 9% in 1986. Also by 2006, non-conventional energy forms would satisfy 13% of the residential demand in all three scenarios; they met 11% of this demand in 1986.

Graph 21 - Distribution of demand by energy form
in the residential sector
(in percent)
1986-2006



- Thus, the assumptions tested in the three scenarios seem to have little effect on the relative importance of each form of energy. It can simply be noted in scenario 3 (low oil price) that the replacement of petroleum products by electricity would be slightly slower in the short term. These assumptions also have a limited impact in the alternative simulations imposing constraints on Hydro-Québec's rates of return: by 2006, the residential electricity consumption in the two simulations would be only 0.3% lower than that in the corresponding reference scenario.

III - The commercial sector

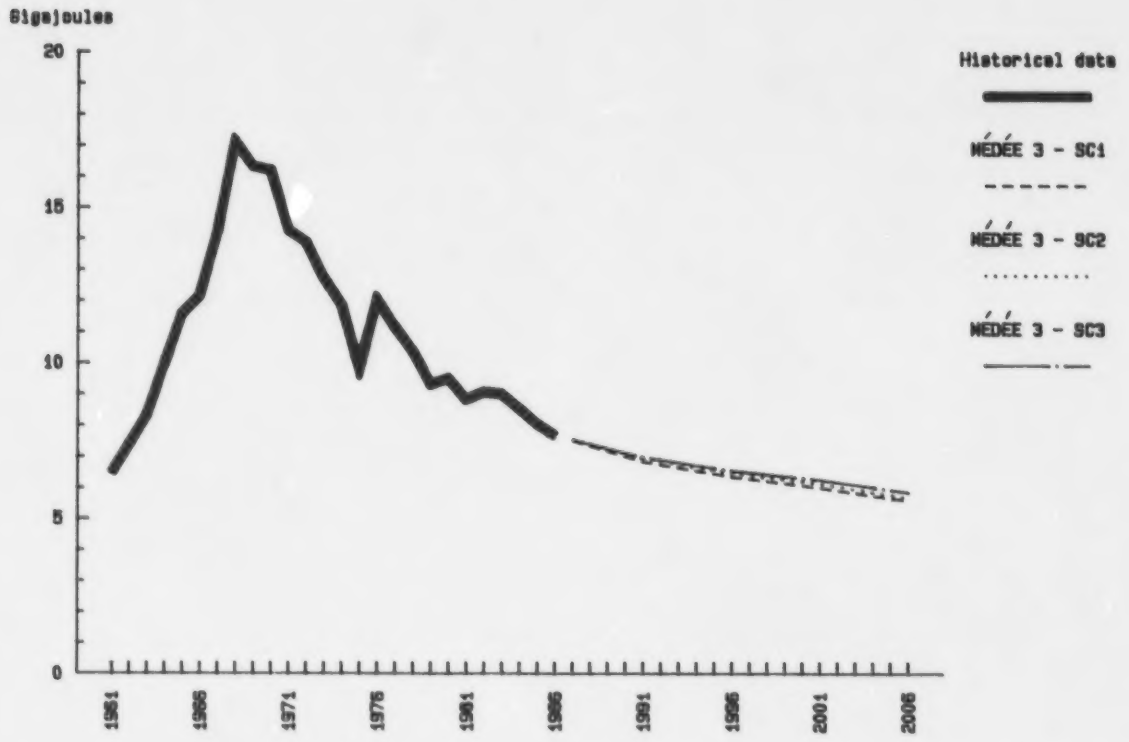
In all three scenarios, commercial energy demand would grow at a moderate rate. Growth would be more sustained in the first subperiod (1986-1996) than in the second (1996-2006). For the period as a whole, commercial energy consumption would grow at an average annual rate of 1.2% (scenario 1), 0.4% (scenario 2) or 1.4% (scenario 3). It is estimated that, by 2006, energy demand in the commercial sector would reach 4.9 million toe (205 PJ) in scenario 1, 4.2 million toe (176 PJ) in scenario 2, and 5.1 million toe (215 PJ) in scenario 3; it was equivalent to 3.9 million toe (162 PJ) in 1986.

The commercial sector includes a wide range of consumers. It not only takes in businesses, properly speaking, but also the institutional sector and all services. We should therefore analyze commercial energy consumption carefully, so as to take into account the diversity of the users involved. However, the energy needs of the commercial sector are roughly similar to those of the residential sector, with space heating accounting for slightly more than half of the energy demand.

In spite of this common feature between the two sectors, the results of our analysis reveal quite different phenomena.

. Contrary to what was observed in the residential sector, commercial energy consumption develops, in all three scenarios, along practically the same lines as energy demand in the economy as a whole. However, commercial energy demand is slightly more sensitive than residential energy demand to changes in the price of crude oil: our analysis shows, for 2006, a difference of 5% between the results of scenarios 1 (high oil price) and 3 (moderate oil price). Also by the end of the period, commercial energy consumption in scenario 1 (high oil price and strong growth) should exceed that of scenario 2 (moderate oil price and slow growth) by 17%. It can be noted that, by 2006, there should be a difference of 19% between the commercial sector GDP in the two scenarios.

Graph 22 - Commercial energy consumption
per thousand dollars of output
(in gigajoules)
1961-2006



The difference in growth between the residential and commercial sectors is relatively easy to explain. Like the residential sector, the commercial sector has recorded major energy savings both through improvements in the efficiency of old constructions and on account of the gradual replacement of old buildings by new, better-insulated ones. However, while the demand for new buildings in the commercial sector is directly related to the economic growth rate, the demand for housing in the residential sector is dependent primarily on population growth, which is very slow in the three scenarios. It is therefore normal that the growth in energy demand will be more sustained in the commercial sector than in the residential one.

. The role played by the various energy forms is another phenomenon that clearly differentiates the commercial sector from the residential one. Initially, the relative importance of each energy form is not the same in the two sectors. Although electricity has taken over similar shares of both the residential and commercial markets (55% in the commercial sector compared to 52% in the residential sector in 1986), natural gas has a much stronger foothold in the commercial sector (25% of commercial energy demand, compared to 9% in the residential sector). This phenomenon can still be observed at the end of the period studied: depending on the scenario, natural gas should monopolize from 22% to 33% of the commercial market, compared to 9% to 11% of the residential one.

It can be noted, in all three scenarios, that there should be a major decline in the role played by oil in meeting demand. Petroleum products, which satisfied 20% of commercial energy demand in 1986, should probably meet only 9% to 11% of this demand by 2006. Although, by the end of the period, oil should still meet 20% of the heating needs of commercial buildings built prior to 1981, it should make few inroads on the new construction market. In scenario 3 (limited oil price increase), the importance of the role played by petroleum products would decline less rapidly than in the first two scenarios.

It can also be noted that natural gas and electricity will compete with one another in their bid to capture the markets left open by petroleum products. In the scenarios, the outcome of this competition is directly related to the comparative prices of these two energy forms and a significant difference can be seen in the results of scenarios 1 and 3.

- In scenario 1 (as in scenario 2), natural gas would lose a great deal of ground to electricity. By 2006, natural gas would control 25% (scenario 1) or 22% (scenario 2) of the commercial market, compared to 25% in 1986. In effect, it is mainly electricity that should benefit from the decline in the role of oil. The share of electricity in commercial energy consumption would rise from 55% in 1986 to 66% in scenario 1 and 68% in scenario 2.

- In scenario 3, on the other hand, the limited increase in oil prices would lead to an equally limited rise in the price of natural gas.[1] As a result, natural gas would have a comparative advantage over electricity throughout the period under study. It should therefore be able to capture a substantial share of the heating market abandoned by oil: 80% in the case of old buildings and approximately 60% in the case of new ones. Thus we

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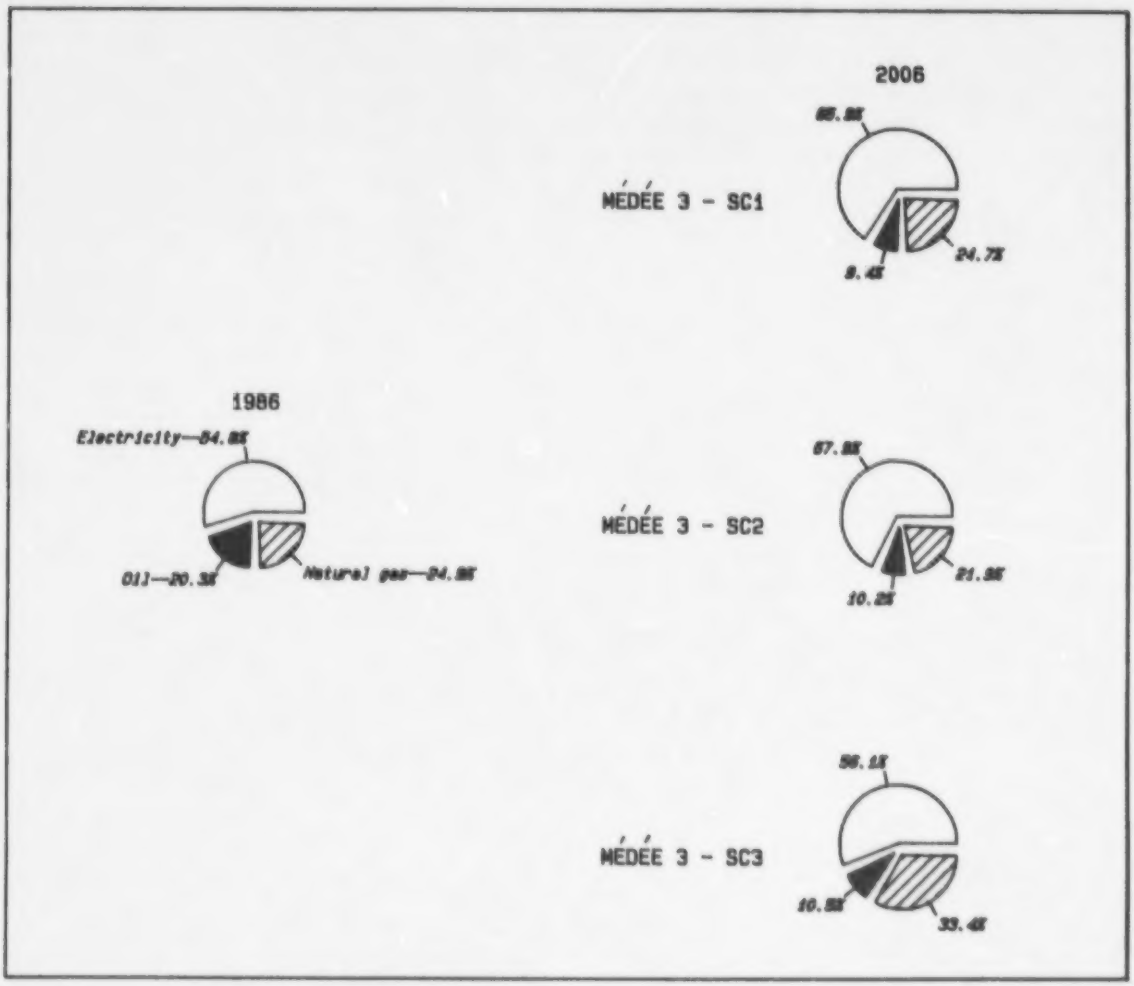
(1) See pages 24 and 25.

Graph 23 - Distribution of demand by energy form in the commercial sector (in percent) 1986-2006



can see why, by the end of the period, natural gas and electricity should meet, respectively, 33% and 56% of commercial energy demand.

The impact of the gas-electricity competition on certain markets in the commercial sector can also be observed in the simulations that imposed constraints on Hydro-Québec's rates of

return. At the end of the period, in simulations 1.14 and 2.14 respectively, electricity consumption should be 4% and 12% lower than in the reference scenario, while gas consumption should be 13% and 24% higher.

IV - The industrial sector

The three scenarios tested show similar patterns in the general growth of energy consumption by the industrial sector: this growth is more sustained in the first subperiod (1986-1996) than in the second (1996-2006) and, in all three cases, it is stronger than the growth in total energy demand. For the period 1986-2006 as a whole, industrial energy demand is estimated to increase at an average annual rate of 1.9% in scenario 1, 1.1% in scenario 2, and 1.8% in scenario 3.

Our results suggest that demand will increase at a rate above that recorded over the past decade (an average of -0.1%), without, however, returning to the levels observed in the 1960s (an average of 3.1% between 1961 and 1976). By 2006, industrial energy demand would amount to 18.1 million toe (758 PJ) in scenario 1, 15.5 million toe (647 PJ) in scenario 2, and 18.0 million toe (753 PJ) in scenario 3.

. We should first emphasize that our results confirm the existence, in the industrial sector, of a phenomenon mentioned earlier - namely, that energy demand and the growth of economic activity are no longer as closely linked as in the past. In all three scenarios, industrial economic growth is approximately one and a half times greater than energy demand growth. The ratio of energy demand to growth in industrial activity is 0.61 in scenario 1, 0.65 in scenario 2, and 0.60 in scenario 3. Between 1961 and 1974, this ratio amounted to 1.0. This phenomenon is all the more remarkable when we consider that all three scenarios bear witness to the very rapid growth of the aluminum industry, a highly energy-intensive industry.

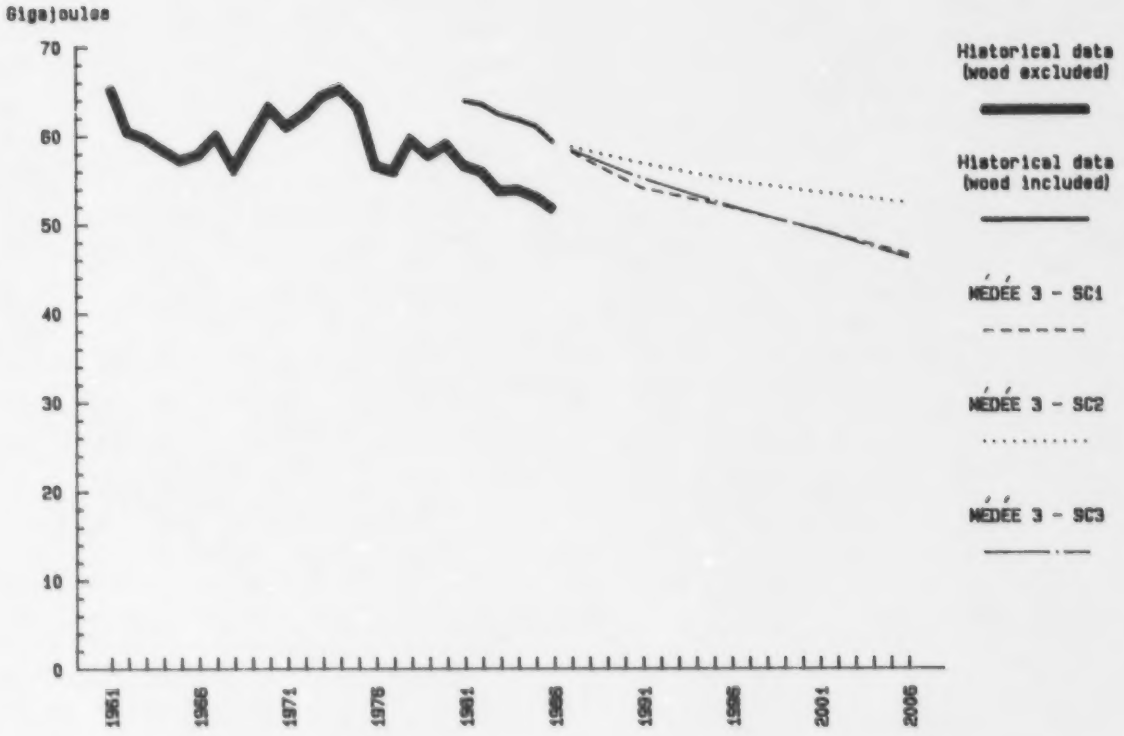
The gap between energy demand and economic growth is also evident in industrial energy consumption per thousand dollars of output. In 1986, such consumption amounted to 1.4 toe (59 GJ). According to our estimates, it would amount to 1.1 toe (47 GJ) in scenario 1, 1.2 toe (52 GJ) in scenario 2, and 1.1 toe (46 GJ) in scenario 3 by 2006.

The gap between energy demand and economic growth can basically be explained by improvements in industrial energy efficiency. In scenario 1, for example, cement works would use only 0.09 toe (3.8 GJ) per tonne of output in 2006, compared to 0.11 toe (4.4 GJ) in 1986. The improvement is especially pronounced in the aluminum industry. In 1986, 2.16 toe (91 GJ) were needed to produce one tonne of aluminum. Our analysis suggests that, by 2006, Québec's aluminum plants would use only 1.78 toe (75 GJ) in scenarios 1 and 2, or 1.80 toe (76 GJ) in scenario 3 to produce

an equivalent amount of aluminum. This translates into an improvement of approximately 17% in energy efficiency in this sector of activity.

. We should also discuss the development of two industries which play an important role in Québec's energy sector, namely, the aluminum and pulp and paper industries. They alone accounted for 53% of Québec's total industrial energy demand in 1986.

Graph 24 - Energy consumption per thousand dollars of output in the industrial sector (in gigajoules) 1961-2006)



- On account of the availability and low cost of electricity in Québec, there should be substantial growth in the production capacity of the aluminum sector.[1] We estimate that, by 2006, electricity consumption in this sector would increase from 18 TWh (1986) to 36 TWh in scenarios 1 and 2, and 32 TWh in scenario 3. The additional energy demand in the aluminum sector would account for 40% (scenario 1), 77% (scenario 2) or 33% (scenario 3) of the increase in industrial energy demand over the 1986-2006 period, and for 37% (scenario 1), 58% (scenario 2) or 37% (scenario 3) of the increase in industrial electricity consumption.

- Our results for the pulp and paper industry can be explained by the fact that this sector is faced with a resource problem, which will dampen production growth.[2] However, since there will be no improvements in the energy efficiency of this sector, energy consumption by the pulp and paper industry should increase at approximately the same rate as that of the industrial sector as a whole - that is, at an annual growth rate of 2.1% (scenario 1), 1.0% (scenario 2) or 2.1% (scenario 3).

With regard to the pattern of energy use in the pulp and paper industry, changes in production techniques will promote the use of electricity at the expense of hydrocarbons. This phenomenon will have major implications for the way in which the relative importance of each energy form will evolve in this sector of activity.

. A third point that should be mentioned concerns the share of each energy form in the industrial sector.

In general, our results provide a complex picture of changes in the role of each energy form on industrial markets. Our first major observation concerns the importance of oil: among the energy sources used by the industrial sector in 1986, petroleum products ranked fourth, after electricity, natural gas and non-conventional energy forms (mainly forest biomass). This diminished role of oil is not called into question in any of the three scenarios: according to our estimates, the share of oil in the industrial energy balance would decrease from 12% in 1986 to 8% in scenario 1, 7% in scenario 2, and 10% in scenario 3 by 2006. Even in scenario 3 (limited oil price increase), the abandonment of petroleum products by most industrial consumers is not called into question.

Over the past decade, the shift away from oil gave considerable impetus to the growth of natural gas and electricity consumption. However, this is no longer the case in any of the scenarios studied: since most petroleum products have already been

(1) See page 17.
(2) See page 17.

replaced, the growth of gas and electricity consumption is entirely dependent on overall demand growth or on the penetration of the market by one of these energy forms at the expense of the other.

Our second major observation concerns, in fact, the competition noted during the simulations between gas and electricity. This competition is fostered by the more widespread use of electrotechnologies and can even be observed on stoking markets. The outcome of this rivalry in our scenarios is closely linked to changes in the competitive position of gas and electricity during the period under study.

- In all three scenarios, natural gas should penetrate, up until the early 1990s, certain markets that are presently controlled by electricity: Hydro-Québec was able to capture these markets through surplus electricity sales.

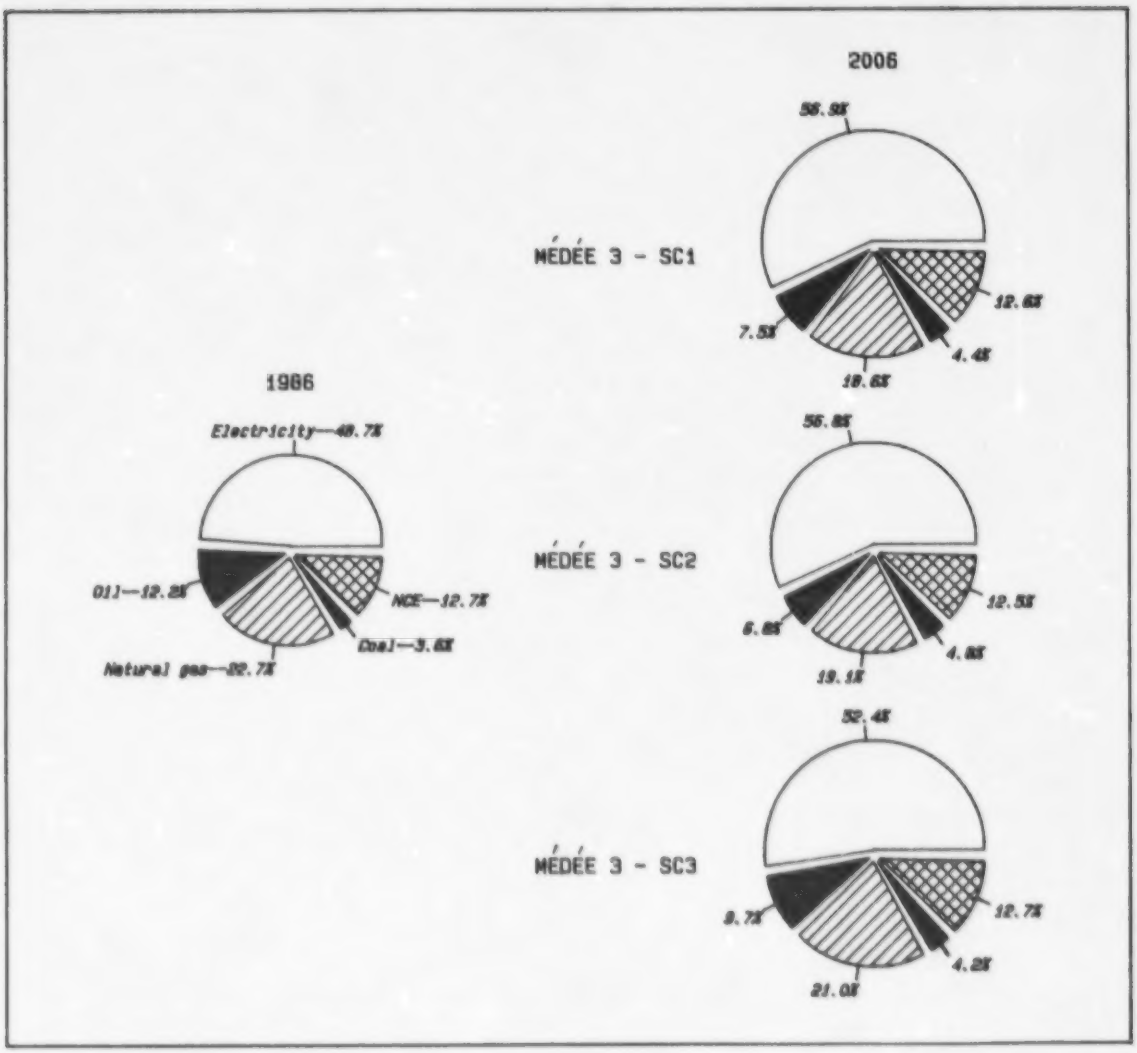
- As of 1996, the situation should be reversed. Improvements in the competitive capacity of electricity should enable Hydro-Québec to supply part of the stoking market through regular electricity sales. This phenomenon, in conjunction with the penetration of electrotechnologies, should lead to renewed growth in the share of electricity in the industrial energy balance, at the expense of natural gas. This phenomenon can be observed in the three scenarios; however, it is less pronounced in scenario 3 (limited oil price increase) than in scenarios 1 and 2. By the end of the period, the respective shares of natural gas and electricity in industrial energy demand would reach 19% and 57% (scenarios 1 and 2), or 21% and 52% (scenario 3); their respective shares in 1986 were 23% and 49%. In scenario 2, the industrial consumption of natural gas would even decline in absolute value relative to the level recorded in 1986.

Our results bring out the enormous sensitivity of certain industrial energy markets to the price of the various forms of energy. The data obtained in the simulations imposing financial constraints on Hydro-Québec confirm this phenomenon: under simulations 1.14 and 2.14 respectively, industrial electricity consumption in 2001 would be 5% and 8% lower than in the reference scenario, while the natural gas demand would be 10% and 20% higher. By 2006, these financial constraints would have a more mitigated effect, for electricity consumption would drop by only 4% according to the two simulations, while natural gas consumption would rise by 10%.

The results obtained can also be explained by the impact of the introduction of electrotechnologies. The assumptions adopted in the three scenarios for the penetration of new electrical processes were described in Chapter 2.[1] The rate at which

(1) See page 18.

Graph 25 - Distribution of demand in the industrial sector
by energy form
(in percent)
1986-2006)



these processes are introduced is all the more rapid in a context of strong economic growth (scenario 1 versus scenario 2) and high oil prices (scenario 1 versus scenario 3). The development of electrotechnologies has a considerable influence on electricity demand in the industrial sector. By 2006, electrotechnologies would account for 8%, 6% and 7% of industrial electricity demand in scenarios 1, 2 and 3 respectively. Moreover, given their high energy efficiency, electrotechnologies should have a very significant impact on total energy demand and the oil and gas markets which they affect. Depending on the scenario, electrotechnologies would replace from 20% to 26% of industrial oil and natural gas consumption by the year 2006.

A third phenomenon is responsible for these results - namely, the behavior of refiners with regard to heavy fuel oil production. Heavy fuel oil is a petroleum by-product obtained during the refining process by which crude oil is converted into light and middle distillates. On account of the residual nature of the product, refiners market heavy fuel oil at prices allowing them to sell off their stock. In the past, this practice has had a significant impact on energy prices in certain industrial markets.

Over the past few years, on account of increased competition between gas and electricity, and government norms restricting the use of heavy fuel oil for environmental reasons, the gap between heavy fuel oil and crude oil prices has prompted refiners to invest in reducing the amount of heavy fuel oil produced during the refining of a barrel of crude oil.

In the scenarios analyzed here, refiners will already have finished making most of their investments for this purpose. It will not be possible for the ensuing decline in the production of heavy fuel oil to be called into question, given the amount of money already invested. This general constraint, combined with the relative profitability of certain heavy fraction markets (asphalt production, marine transport), will make it more difficult for this product to reappear on Québec's industrial market. In fact, its reappearance would presuppose recourse to importation, a situation explicitly ruled out in the scenarios studied. Even under scenario 3, heavy fuel oil would not recover industrial stoking markets, largely because of factors related to supply.

V - The transportation sector

Between 1980 and 1983, energy consumption by the transportation sector fell abruptly, declining by 25% in absolute value. As specified above, this trend was reversed in 1984. The results obtained in the three scenarios confirm this recovery in demand growth, although to varying degrees. Our results suggest that, for the 1986-2006 period as a whole, transportation energy demand

would increase at an average annual rate of 0.8% in scenario 1, 0.6% in scenario 2, and 1.4% in scenario 3. By 2006, energy demand in this sector would reach 10.1 million toe (420 PJ) in scenario 1, 9.7 million toe (408 PJ) in scenario 2, and 11.3 million toe (472 PJ) in scenario 3.

. At the aggregate level, our results bring out two interesting patterns:

- First, in all three scenarios, the results are divided fairly clearly into two subperiods. In the three simulations, transportation energy demand varies little until 1991. Subsequently, there is a more or less marked recovery in growth up through the end of the period studied. This phenomenon can be largely attributed to the fact that automobiles built before 1980 will continue to be replaced by more fuel-efficient cars between 1986 and 1991. Subsequently, the replacement of the old automobile stock will not entail such marked improvements in average fuel efficiency. It can be noted that, in the transportation sector, the distribution of demand growth over time is different from that observed for total energy demand.

- Secondly, energy demand in the transportation sector seems to be sensitive to the oil price assumptions that we selected. In 2006, the energy demand in the low price scenario (scenario 3) would be 12% higher than that in the high price one (scenario 1). On the other hand, there would be a gap of only 3% between scenarios 1 (strong economic growth) and 2 (slow economic growth and moderate oil price) by the end of the period.

. Several factors are responsible for the results obtained. These factors are related to transportation needs themselves, to the equipment used and to energy savings that affect consumption by this equipment. On the whole, the growth of transportation needs tends to increase energy demand; changes in the type of equipment used have a relatively limited effect on this demand, while improvements in their fuel efficiency have significant implications for consumption, especially for the period 1986-1991.

- Transportation needs are determined by a number of factors affecting the urban and interurban transport of passengers and goods.[1] In all three scenarios, it can be noted that transportation needs should increase substantially over the period as a whole. It can also be noted, however, that urban passenger transport is much less sensitive than interurban passenger or goods transport to differences in economic growth. Between 1986 and 2006, urban passenger transport needs would increase by 53% in scenarios 1 and 3, and by 44% in scenario 2. During the same period, interurban transportation needs would grow by 70% in

(1) See page 21.

scenarios 1 and 3, and by 46% in scenario 2. Similarly, goods transport needs would increase by 45% in scenarios 1 and 3, and 29% in scenario 2.

- With regard to the equipment used, it can be seen that the relative importance of the various modes of transport is relatively stable. In 2006, the automobile would account for 53% (scenarios 1 and 3) or 54% (scenario 2) of transportation energy demand, compared to 54% in 1986. In all three scenarios, it can be noted that there should be a slight decline in the role played by mass transit in urban passenger transport, while the airplane should be used more frequently in passenger travel between cities. The share of the airplane in interurban travel would increase from 41% to 45% (scenario 1), 43% (scenario 2) or 45% (scenario 3).

- Changes in the fuel efficiency of the transportation equipment used also explain the results obtained. In the three scenarios analyzed, we can observe a further decline in the consumption per type of transportation equipment. These reductions affect all modes of transport, especially the airplane and automobile. In the case of the airplane, we must take into account not only the technical improvements made in the aircraft themselves but also the impact of the longer distances travelled.

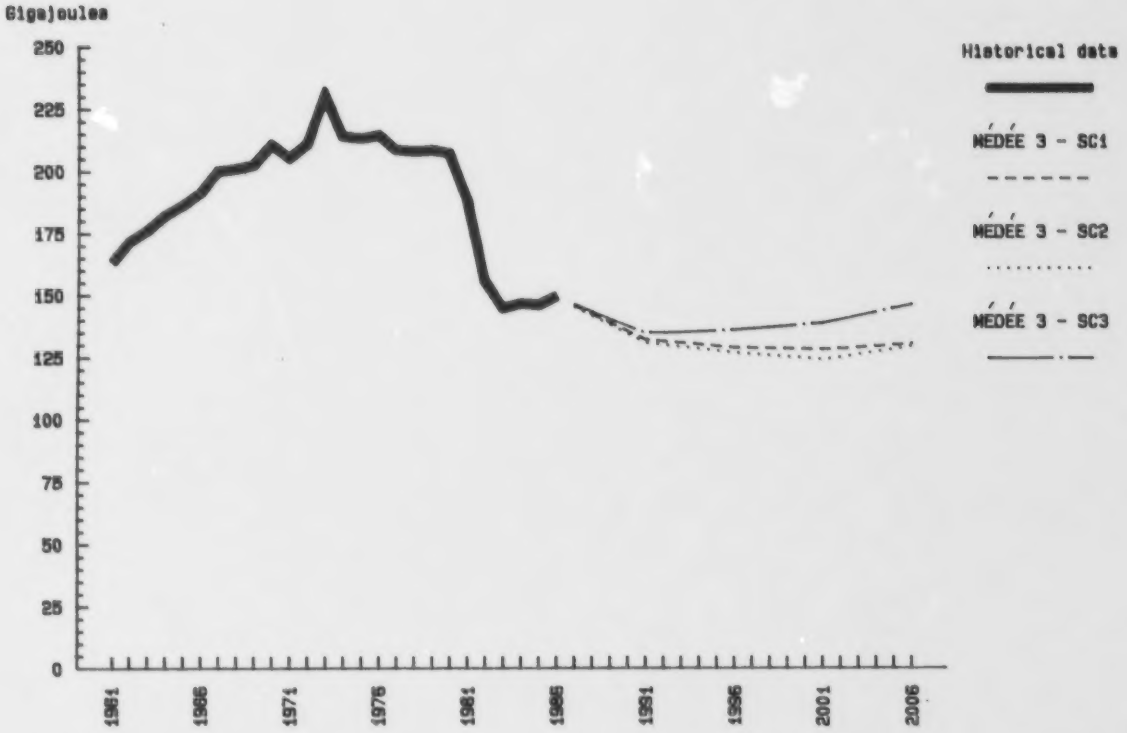
In the case of the automobile, average consumption would decline by 29% in scenario 1, 25% in scenario 2, and 20% in scenario 3 between 1986 and 2006. Although this is a substantial decline, it is less rapid than that observed over the past few years (average energy consumption by automobiles dropped by 22% between 1980 and 1986).

Average automobile consumption is dependent on the performance of each type of vehicle (small, sub-compact, compact, intermediate, or standard) and on the way in which consumers choose from among these various alternatives. Changes in these two determinants are primarily related, in the first case, to the price of fuel and to government norms and, in the second case, to fuel prices, income levels and the size of households. It can be noted that the average consumption of the total automobile stock changes significantly when we use different crude oil price assumptions (scenario 1 versus scenario 3). However, the differences between our results for average consumption by the automobile stock would have been more important except that most technical improvements have already been implemented and that few additional breakthroughs are anticipated before the beginning of the 1990s.

. In conclusion, we will analyze the breakdown of the transportation energy market according to forms of energy.

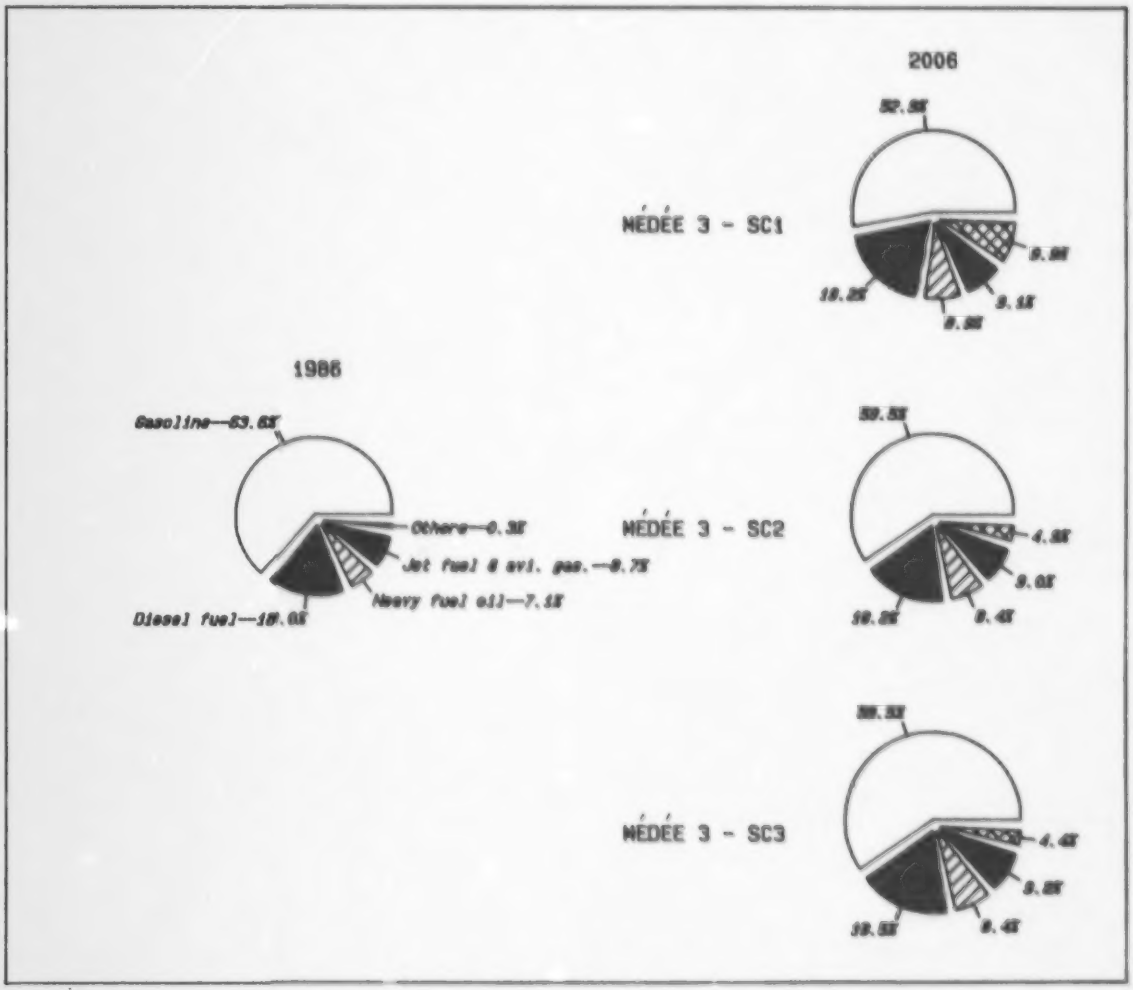
The results we obtained in the three scenarios imply that the transportation sector will basically remain a captive market

Graph 26 - Energy consumption per household
in the transportation sector
(in gigajoules)
1961-2006



for petroleum products up through 2006. The inroads made by natural gas (natural gas for vehicles) and, especially, methanol and ethanol, will probably not have significant repercussions. By the end of the period, oil would meet 91% (scenario 1) or 96% (scenarios 2 and 3) of transportation energy demand.

Graph 27 - Distribution of demand by energy form
in the transportation sector
(in percent)
1986-2006



In all three scenarios, there should be a decline in the relative importance of gasoline on the transportation market. This decline is less pronounced in scenario 3. The other petroleum products - diesel fuel, jet fuel, aviation gasoline and heavy fuel oil - should maintain market shares relatively similar

to those observed in 1986. However, our results suggest that, by the end of the period, the share of gasoline in the total energy balance would still amount to 53% in scenario 1, and 60% in scenarios 2 and 3; its total share in 1986 was equivalent to 65%.

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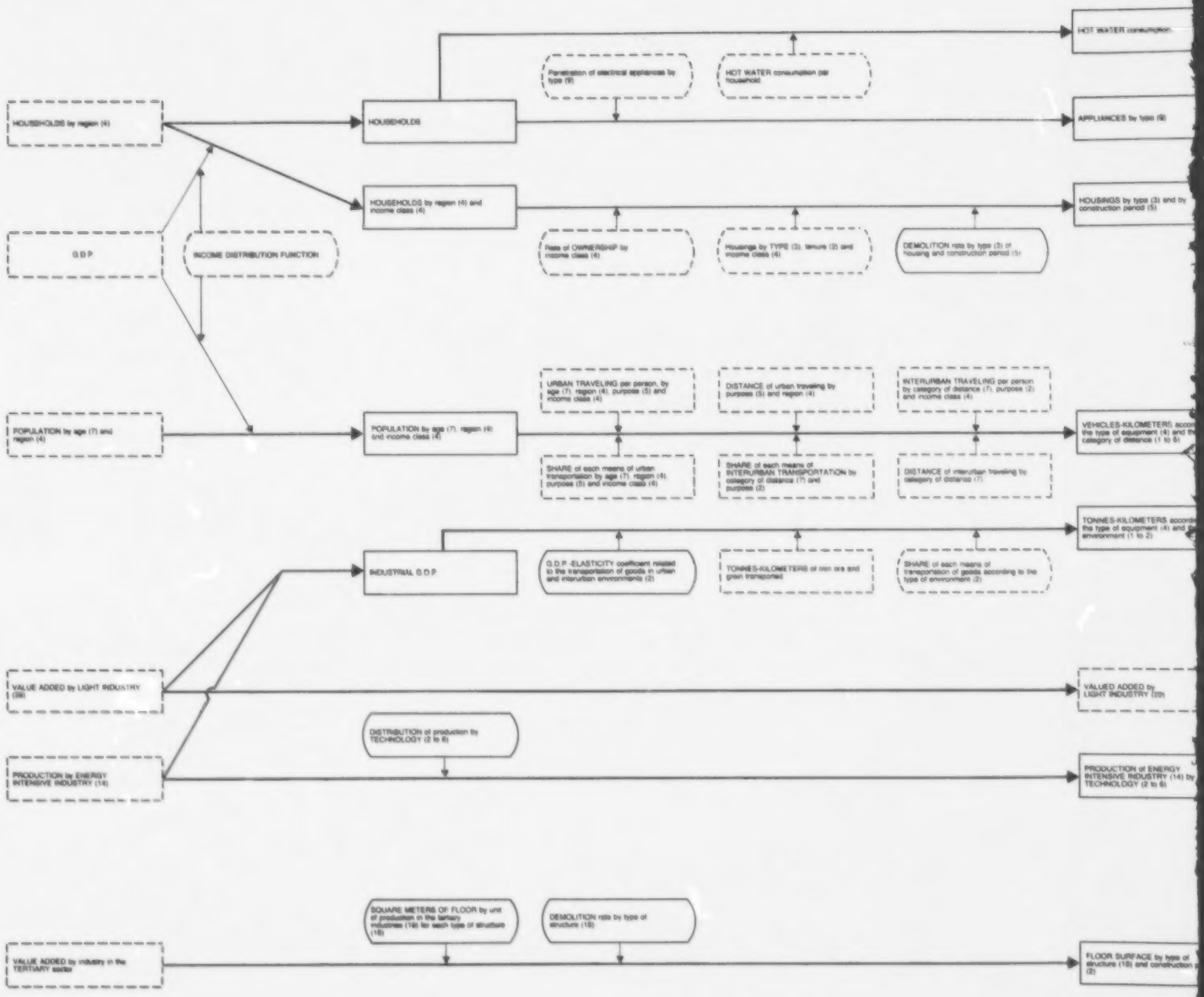
* *

Gouvernement du Québec
Ministère de l'Énergie
et des Ressources

SOCIO-ECONOMIC SCENARIO

NEEDS OF ACTIVITIES

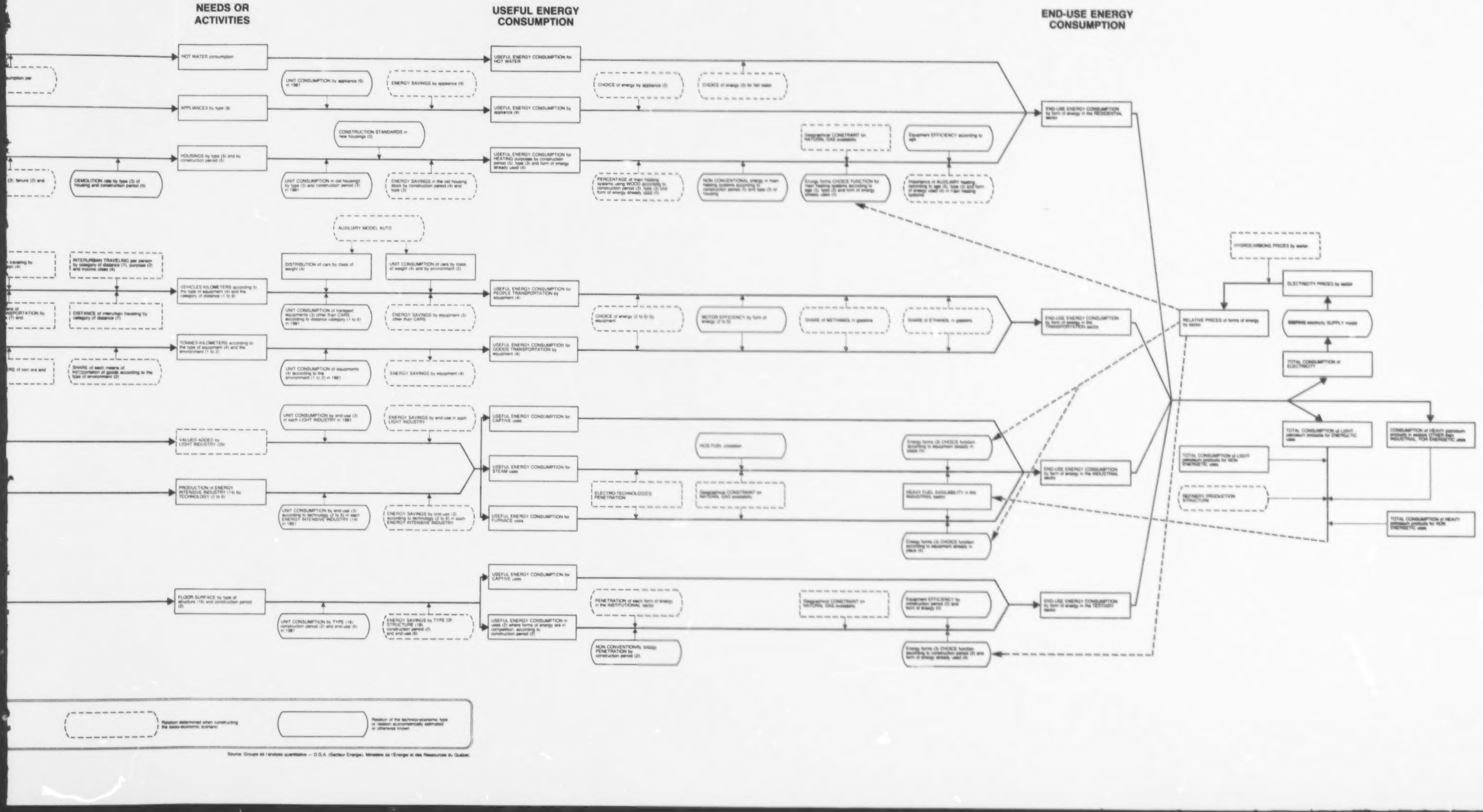

HOUSEHOLDS by region (4)
HOUSEHOLDS
Penetration of electrical appliances by type (9)
HOT WATER consumption per household
HOT WATER consumption
APPLIANCES by type (9)
HOUSEHOLDS by region (4) and income class (4)
HOUSINGS by type (3) and by construction period (5)
G.D.P
INCOME DISTRIBUTION FUNCTION
Rate of OWNERSHIP by income class (4)
Housings by TYPE (3), tenure (2) and income class (4)
DEMOLITION rate by type (3) of housing and construction period (5)
URBAN TRAVELING per person, by age (7), region (4), purpose (5) and income class (4)
DISTANCE of urban traveling by purpose (5) and region (4)
INTERURBAN TRAVELING per person by category of distance (7), purpose (2) and income class (4)
POPULATION by age (7) and region (4)
POPULATION by age (7), region (4) and income class (4)
VEHICLES-KILOMETERS
SHARE of each means of urban transportation by age (7), region (4), purpose (5) and income class (4)
SHARE of each means of INTERURBAN TRANSPORTATION by category of distance (7) and purpose (2)
DISTANCE of interurban traveling by category of distance (7)
TONNES-KILOMETERS
INDUSTRIAL G.D.P
G.D.P.-ELASTICITY coefficient related to the transportation of goods in urban and interurban environments (2)
TONNES-KILOMETERS of coal, ore and grain transported
SHARE of each means of transportation of goods according to the type of environment (2)
VALUE ADDED by LIGHT INDUSTRY (39)
VALUED ADDED by LIGHT INDUSTRY (39)
DISTRIBUTION of production by TECHNOLOGY (2 to 6)
PRODUCTION by ENERGY INTENSIVE INDUSTRY (14)
PRODUCTION of ENERGY INTENSIVE INDUSTRY (14) by TECHNOLOGY (2 to 6)
SQUARE METERS OF FLOOR by unit of production in the tertiary industries (16) for each type of structure (18)
DEMOLITION rate by type of structure (18)
VALUE ADDED by industry in the TERTIARY sector
FLOOR SURFACE by type of structure (18) and construction
(2)

LEGEND

- Variable determined when constructing the socio-economic scenario
- Variable obtained through the model calculations
- Relation determined when constructing the socio-economic scenario

[1] MEDEE-3 QUÉBEC has been jointly developped by the I.N.R.S.-Énergie and the ministère de l'Énergie et des Ressources du Québec according to MEDEE basic approach set forth by the Institut Économique et Juridique de l'Énergie de Grenoble.

DIAGRAM OF MÉDÉE-3 QUÉBEC[1]


NEEDS OR ACTIVITIES
USEFUL ENERGY CONSUMPTION
END-USE ENERGY CONSUMPTION
HOT WATER consumption
APPLIANCES by type (9)
HOUSINGS by type (3) and by construction period (5)
VEHICLES KILOMETERS according to the type of equipment (4) and the category of distance (1 to 6)
TONNES-KILOMETERS according to the type of equipment (4) and the environment (1 to 2)
VALUED ADDED by LIGHT INDUSTRY (20)
PRODUCTION of ENERGY INTENSIVE INDUSTRY (14) by TECHNOLOGY (1 to 8)
FLOOR SURFACE by type of structure (18) and construction period (2)
DEMOLITION rate by type (3) of housing and construction period (5)
INTERURBAN TRAVELING per person by category of distance (7), purpose (3) and income class (4)
DISTANCE of interurban traveling by category of distance (7)
SHARE of each means of transportation of goods according to the type of environment (2)
UNIT CONSUMPTION by appliance (9) in 1981
ENERGY SAVINGS by appliance (9)
CONSTRUCTION STANDARDS in new housings (3)
UNIT CONSUMPTION in old housings by type (3) and construction period (5) in 1981
ENERGY SAVINGS in the old housing stock by construction period (4) and type (3)
AUXILIARY MODEL AUTO
DISTRIBUTION of cars by class of weight (4)
UNIT CONSUMPTION of cars by class of weight (4) and by environment (2)
UNIT CONSUMPTION of transport equipments (3) other than CARS according to distance category (1 to 6) in 1981
ENERGY SAVINGS by equipment (3) other than CARS
UNIT CONSUMPTION of equipments (4) according to the environment (1 to 2) in 1981
ENERGY SAVINGS by equipment (4)
UNIT CONSUMPTION by end-use (3) in each LIGHT INDUSTRY in 1981
ENERGY SAVINGS by end-use in each LIGHT INDUSTRY
UNIT CONSUMPTION by end-use (3) according to technology (2 to 8) in each ENERGY INTENSIVE INDUSTRY (14) in 1981
ENERGY SAVINGS by end-use (3) according to technology (2 to 8) in each ENERGY INTENSIVE INDUSTRY
UNIT CONSUMPTION by TYPE (18), construction period (2) and end-use (6) in 1981
ENERGY SAVINGS by TYPE OF STRUCTURE (18), construction period (2) and end-use (6)
USEFUL ENERGY CONSUMPTION for HOT WATER
USEFUL ENERGY CONSUMPTION by appliance (9)
USEFUL ENERGY CONSUMPTION for HEATING purposes by construction period (5), type (3) and form of energy already used (4)
USEFUL ENERGY CONSUMPTION for PEOPLE TRANSPORTATION by equipment (4)
USEFUL ENERGY CONSUMPTION for GOODS TRANSPORTATION by equipment (4)
USEFUL ENERGY CONSUMPTION for CAPTIVE uses
USEFUL ENERGY CONSUMPTION for STEAM uses
USEFUL ENERGY CONSUMPTION for FURNACE uses
USEFUL ENERGY CONSUMPTION for CAPTIVE uses
USEFUL ENERGY CONSUMPTION in uses (2) where forms of energy are in competition, according to construction period (2)
CHOICE of energy by appliance (9)
CHOICE of energy (3) for hot water
PERCENTAGE of main heating systems using WOOD according to construction period (3), type (3) and form of energy already used (4)
NON CONVENTIONAL energy in main heating systems according to construction period (5) and type (3) of housing
Energy forms CHOICE FUNCTION for main heating systems according to age (5), type (3) and form of energy already used (4)
Importance of AUXILIARY heating according to age (5), type (3) and form of energy used (4) in main heating systems
CHOICE of energy (2 to 6) by equipment
MOTOR EFFICIENCY by form of energy (2 to 6)
SHARE of METHANOL in gasoline
SHARE of ETHANOL in gasoline
RGS FUEL chosen
ELECTRO-TECHNOLOGIES PENETRATION
PENETRATION of each form of energy in the INSTITUTIONAL sector
NON CONVENTIONAL energy PENETRATION by construction period (2)
Geographical CONSTRAINT on NATURAL GAS availability
Energy forms (3) CHOICE function according to equipment already in place (4)
HEAVY FUEL AVAILABILITY in the INDUSTRIAL sector
Equipment EFFICIENCY according to age
Energy forms (3) CHOICE function according to construction period (2) and form of energy already used (4)
END-USE ENERGY CONSUMPTION by form of energy in the RESIDENTIAL sector
END-USE ENERGY CONSUMPTION by form of energy in the TRANSPORTATION sector
END-USE ENERGY CONSUMPTION by form of energy in the INDUSTRIAL sector
END-USE ENERGY CONSUMPTION by form of energy in the TERTIARY sector
HYDROCARBONS PRICES by sector
ELECTRICITY PRICES by sector
RELATIVE PRICES of forms of energy by sector
ENERGY electricity SUPPLY model
TOTAL CONSUMPTION of ELECTRICITY
REFINERY PRODUCTION STRUCTURE
TOTAL CONSUMPTION of LIGHT petroleum products for ENERGETIC uses
TOTAL CONSUMPTION of LIGHT petroleum products for NON-ENERGETIC uses
CONSUMPTION of HEAVY petroleum products in sectors OTHER than INDUSTRIAL, FOR ENERGETIC uses
TOTAL CONSUMPTION of HEAVY petroleum products for NON-ENERGETIC uses
Relation determined when constructing the socio-economic scenario
Relation of the technico-economic type or relation econometrically estimated or otherwise known

Source: Groupe de l'analyse quantitative — D.G.A. (Secteur Energie), Ministère de l'Energie et des Ressources du Québec

Gouvernement du Québec
Ministère de l'Énergie et des Ressources

SCENARIOS FOR QUEBEC'S ENERGY DEMAND INCLUDING TOTAL WOOD CONSUMPTION IN NATURAL UNITS

MEDEE 3 – SC1

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	42.9	51.8	49.6	60.4	56.5	67.7	61.1	71.3	63.6	72.5	2.8	1.2
Natural gas	26.6	9.4	33.6	12.0	31.2	11.0	30.7	10.5	30.4	10.2	1.6	-0.2
Oil	36.7	27.6	20.2	15.2	11.4	8.4	7.6	5.3	6.7	4.6	-11.2	-5.3
- light fuel oil	33.1	24.9	16.5	12.5	7.3	5.5	3.0	2.2	1.5	1.1	-14.0	-14.6
- diesel fuel	1.5	1.1	1.7	1.3	2.0	1.5	2.3	1.7	2.7	1.9	2.8	2.9
- heavy fuel oil	0.8	0.6	0.4	0.3	0.2	0.1	0.1	0.1	0.0	0.0	-14.4	-12.9
- gasoline	1.3	0.9	1.6	1.1	1.9	1.3	2.2	1.4	2.5	1.6	3.9	2.8
Non-conv. energy	33.4	11.2	36.4	12.3	38.9	13.0	39.8	12.9	40.4	12.8	1.5	0.4
Residential total	**298.1**	**100.0**	**295.3**	**100.0**	**300.3**	**100.0**	**308.7**	**100.0**	**315.9**	**100.0**	**0.1**	**0.5**
COMMERCIAL												
Electricity	24.7	54.8	25.3	54.5	28.4	56.3	32.3	59.5	37.6	65.9	1.4	2.8
Natural gas	38.3	24.9	41.7	26.3	50.0	29.0	52.8	28.5	48.1	24.7	2.7	-0.4
Oil	14.5	20.3	14.0	19.2	11.8	14.8	10.3	12.0	8.5	9.4	-2.0	-3.3
- light fuel oil	9.1	12.6	8.3	11.1	6.6	8.1	5.5	6.3	4.1	4.5	-3.2	-4.5
- diesel fuel	2.4	3.3	2.5	3.3	2.8	3.4	3.0	3.5	3.3	3.7	1.6	1.9
- heavy fuel oil	3.0	4.5	3.3	4.8	2.5	3.3	1.8	2.2	1.0	1.2	-1.9	-8.8
Commercial total	**162.3**	**100.0**	**167.3**	**100.0**	**182.0**	**100.0**	**195.5**	**100.0**	**205.1**	**100.0**	**1.2**	**1.2**
INDUSTRIAL												
Electricity	70.8	48.7	72.5	45.4	90.5	49.9	103.9	53.0	119.9	56.9	2.5	2.8
Natural gas	112.5	22.7	147.8	27.1	142.2	23.0	139.1	20.8	133.6	18.6	2.4	-0.6
Oil	27.4	12.2	25.6	10.3	26.1	9.2	26.7	8.7	24.7	7.5	-0.5	-0.6
- light fuel oil	5.5	2.4	4.5	1.8	3.9	1.3	3.6	1.1	2.5	0.7	-3.5	-4.5
- diesel fuel	9.2	3.9	9.8	3.6	11.6	4.0	13.0	4.1	14.6	4.3	2.4	2.3
- heavy fuel oil	12.7	5.9	11.2	4.7	10.6	3.9	10.2	3.5	7.7	2.5	-1.8	-3.1
Coal and coke	708.0	3.6	894.3	4.2	1 054.5	4.3	1 147.7	4.4	1 248.3	4.4	4.1	1.7
Non-conv. energy	66.6	12.7	74.4	12.9	88.8	13.6	92.5	13.1	95.5	12.6	2.9	0.7
Industrial total	**522.9**	**100.0**	**574.9**	**100.0**	**653.3**	**100.0**	**706.0**	**100.0**	**758.4**	**100.0**	**2.3**	**1.5**
TRANSPORTATION												
Electricity	0.3	0.3	0.4	0.4	0.5	0.5	0.7	0.6	1.0	0.9	3.5	7.8
Natural gas	0.0	0.0	2.4	0.7	6.7	1.9	8.2	2.2	11.4	2.9	94.9	5.4
Gasoline	116.5	65.0	106.4	61.1	102.5	55.9	104.9	53.9	110.9	53.0	-1.3	0.8
Diesel fuel	29.5	18.4	30.2	19.4	34.0	20.7	35.4	20.3	36.0	19.2	1.5	0.6
Jet fuel and avi. gas	15.5	8.9	15.3	9.1	16.9	9.5	17.8	9.5	18.4	9.1	0.9	0.8
Heavy fuel oil	10.9	7.3	11.6	8.1	12.8	8.4	14.3	8.8	15.5	8.9	1.7	1.9
Non-conv. energy	0.1	0.0	4.4	1.3	10.9	3.0	18.4	4.7	25.6	6.1	59.9	8.9
Road	284.0	78.8	271.2	77.5	281.7	76.5	297.9	76.1	320.4	76.1	-0.1	1.3
Rail	11.5	3.2	12.1	3.5	12.8	3.5	13.5	3.4	14.0	3.3	1.1	0.9
Air	32.2	8.9	31.9	9.1	35.1	9.5	37.0	9.5	39.0	9.3	0.9	1.1
Sea	32.5	9.0	34.3	9.8	38.0	10.3	41.8	10.7	45.5	10.8	1.6	1.8
Transportation total	**360.2**	**100.0**	**350.1**	**100.0**	**368.4**	**100.0**	**391.5**	**100.0**	**420.8**	**100.0**	**0.2**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	138.7	37.2	147.8	38.3	175.9	42.1	198.1	44.5	222.0	47.0	2.4	2.4
Natural gas	177.4	13.9	225.5	17.1	230.0	16.1	230.8	15.2	223.5	13.9	2.6	-0.3
Oil	250.9	40.0	223.5	34.5	215.5	30.7	216.9	28.9	220.7	27.7	-1.5	0.2
- light fuel oil	47.7	8.0	29.3	4.7	17.7	2.6	12.0	1.7	8.1	1.1	-9.4	-7.5
- diesel fuel	42.5	7.1	44.2	7.1	50.4	7.5	53.7	7.5	56.6	7.5	1.7	1.2
- heavy fuel oil	27.4	4.9	26.6	4.6	26.1	4.2	26.3	4.0	24.3	3.5	-0.5	-0.7
- gasoline	117.8	17.6	108.0	15.7	104.4	14.0	107.1	13.4	113.4	13.4	-1.2	0.8
- jet fuel and avi. gas	15.5	2.4	15.3	2.3	16.9	2.3	17.8	2.3	18.4	2.2	0.9	0.8
Coal and coke	708.0	1.4	894.3	1.7	1 054.5	1.9	1 147.7	1.9	1 248.3	2.0	4.1	1.7
Non-conv. energy	100.1	7.5	115.2	8.3	138.6	9.2	150.7	9.4	161.5	9.5	3.3	1.5
Total demand	**1 343.5**	**100.0**	**1 387.6**	**100.0**	**1 504.0**	**100.0**	**1 601.7**	**100.0**	**1 700.2**	**100.0**	**1.1**	**1.2**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

notes: – Electricity: in TWh
– Natural gas: in billions of cubic feet
– Oil: in thousands of barrels/day
– Coal and coke: in thousands of short tons
– Others: in petajoules

MEDEE 3 – SC2

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	42.9	51.8	49.8	61.5	56.5	68.9	60.9	72.6	63.2	73.9	2.8	1.1
Natural gas	26.6	9.4	30.4	11.0	28.1	10.0	27.7	9.7	27.5	9.4	0.5	-0.2
Oil	36.7	27.6	19.7	15.1	10.7	8.0	6.6	4.8	5.4	3.8	-11.7	-6.8
- light fuel oil	33.1	24.9	16.3	12.6	7.2	5.5	3.0	2.2	1.5	1.1	-14.2	-14.4
- diesel fuel	1.5	1.1	1.6	1.2	1.7	1.3	1.8	1.4	2.0	1.5	1.4	1.4
- heavy fuel oil	0.8	0.6	0.4	0.3	0.2	0.1	0.1	0.1	0.0	0.0	-14.4	-12.9
- gasoline	1.3	0.9	1.4	1.0	1.6	1.1	1.7	1.2	1.8	1.2	2.1	1.5
Non-conv. energy	33.4	11.2	36.1	12.4	38.5	13.0	39.3	13.0	39.8	12.9	1.4	0.3
Residential total	**298.1**	**100.0**	**291.3**	**100.0**	**295.1**	**100.0**	**302.4**	**100.0**	**308.1**	**100.0**	**-0.1**	**0.4**
COMMERCIAL												
Electricity	24.7	54.8	24.5	53.9	27.9	58.7	30.4	62.4	33.2	67.9	1.2	1.8
Natural gas	38.3	24.9	40.6	26.2	41.5	25.6	41.1	24.7	36.5	21.9	0.8	-1.3
Oil	14.5	20.3	14.2	19.9	11.7	15.6	9.9	12.9	7.9	10.2	-2.1	-3.9
- light fuel oil	9.1	12.6	8.4	11.6	6.6	8.7	5.3	6.8	4.0	5.1	-3.2	-4.9
- diesel fuel	2.4	3.3	2.4	3.2	2.5	3.3	2.7	3.4	2.8	3.6	0.7	1.0
- heavy fuel oil	3.0	4.5	3.4	5.1	2.6	3.6	1.9	2.7	1.1	1.5	-1.6	-8.0
Commercial total	**162.3**	**100.0**	**163.4**	**100.0**	**170.8**	**100.0**	**175.6**	**100.0**	**176.0**	**100.0**	**0.5**	**0.3**
INDUSTRIAL												
Electricity	70.8	48.7	67.4	43.0	93.9	56.7	96.4	55.9	102.1	56.8	2.9	0.8
Natural gas	112.5	22.7	162.5	30.4	112.2	19.9	117.4	20.0	117.2	19.1	-0.0	0.4
Oil	27.4	12.2	24.1	9.9	16.0	6.2	18.3	6.8	19.1	6.8	-5.3	1.8
- light fuel oil	5.5	2.4	3.9	1.5	1.4	0.5	1.9	0.7	2.0	0.7	-12.9	3.8
- diesel fuel	9.2	3.9	9.0	3.6	9.5	3.6	9.8	3.6	10.2	3.5	0.4	0.7
- heavy fuel oil	12.7	5.9	11.3	4.8	5.1	2.1	6.5	2.5	6.9	2.6	-8.7	3.0
Coal and coke	708.0	3.6	868.2	4.1	1 002.4	4.5	1 073.1	4.6	1 147.7	4.8	3.5	1.4
Non-conv. energy	66.6	12.7	70.9	12.6	76.0	12.7	78.4	12.6	80.8	12.5	1.3	0.6
Industrial total	**522.9**	**100.0**	**564.2**	**100.0**	**596.3**	**100.0**	**620.2**	**100.0**	**646.7**	**100.0**	**1.3**	**0.8**
TRANSPORTATION												
Electricity	0.3	0.3	0.4	0.4	0.5	0.5	0.7	0.7	1.0	0.9	3.5	7.8
Natural gas	0.0	0.0	1.5	0.5	2.7	0.8	4.1	1.1	5.4	1.4	78.2	7.0
Gasoline	116.5	65.0	106.5	62.0	105.7	59.1	108.7	58.4	120.7	59.5	-1.0	1.3
Diesel fuel	29.5	18.4	29.6	19.2	32.8	20.5	32.9	19.8	33.1	18.2	1.1	0.1
Jet fuel and avi. gas	15.5	8.9	15.1	9.1	16.3	9.5	17.1	9.5	17.7	9.0	0.5	0.8
Heavy fuel oil	10.9	7.3	11.7	8.2	12.5	8.4	13.4	8.7	14.2	8.4	1.4	1.2
Non-conv. energy	0.1	0.0	2.2	0.6	4.4	1.2	6.8	1.8	10.5	2.6	46.0	9.1
Road	284.0	78.8	267.0	77.3	275.0	76.5	284.8	76.1	314.0	77.0	-0.3	1.3
Rail	11.5	3.2	12.0	3.5	12.4	3.4	12.7	3.4	12.9	3.2	0.8	0.4
Air	32.2	8.9	31.4	9.1	34.0	9.5	35.6	9.5	37.3	9.1	0.5	0.9
Sea	32.5	9.0	34.4	10.0	37.0	10.3	39.2	10.5	41.6	10.2	1.3	1.2
Transportation total	**360.2**	**100.0**	**345.5**	**100.0**	**359.5**	**100.0**	**374.0**	**100.0**	**408.0**	**100.0**	**-0.0**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	138.7	37.2	141.9	37.5	178.8	45.3	188.4	46.1	199.5	46.7	2.6	1.1
Natural gas	177.4	13.9	235.0	18.2	184.5	13.7	190.3	13.6	186.5	12.8	0.4	0.1
Oil	250.9	40.0	221.0	34.7	205.8	30.8	206.9	29.9	218.1	30.0	-2.0	0.5
- light fuel oil	47.7	8.0	28.6	4.7	15.2	2.4	10.2	1.6	7.5	1.1	-10.8	-6.8
- diesel fuel	42.5	7.1	42.5	7.0	46.7	7.4	47.3	7.2	48.1	7.0	0.9	0.3
- heavy fuel oil	27.4	4.9	26.8	4.8	20.4	3.5	21.9	3.6	22.2	3.5	-2.9	0.9
- gasoline	117.8	17.6	108.0	15.9	107.3	15.2	110.4	15.1	122.5	16.0	-0.9	1.3
- jet fuel and avi. gas	15.5	2.4	15.1	2.3	16.3	2.4	17.1	2.4	17.7	2.4	0.5	0.8
Coal and coke	708.0	1.4	868.2	1.7	1 002.4	1.9	1 073.1	2.0	1 147.7	2.0	3.5	1.4
Non-conv. energy	100.1	7.5	109.2	8.0	118.9	8.4	124.5	8.5	131.1	8.5	1.7	1.0
Total demand	**1 343.5**	**100.0**	**1 364.4**	**100.0**	**1 421.7**	**100.0**	**1 472.2**	**100.0**	**1 538.8**	**100.0**	**0.6**	**0.8**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

notes: – Electricity: in TWh
– Natural gas: in billions of cubic feet
– Oil: in thousands of barrels/day
– Coal and coke: in thousands of short tons
– Others: in petajoules

MEDEE 3 – SC3

	1986
RESIDENTIAL	
Electricity	42.9
Natural gas	26.6
Oil	36.7
- light fuel oil	33.1
- diesel fuel	1.5
- heavy fuel oil	0.8
- gasoline	1.3
Non-conv. energy	33.4
Residential total	**298.1**
COMMERCIAL	
Electricity	24.7
Natural gas	38.3
Oil	14.5
- light fuel oil	9.1
- diesel fuel	2.4
- heavy fuel oil	3.0
Commercial total	**162.3**
INDUSTRIAL	
Electricity	70.8
Natural gas	112.5
Oil	27.4
- light fuel oil	5.5
- diesel fuel	9.2
- heavy fuel oil	12.7
Coal and coke	708.0
Non-conv. energy	66.6
Industrial total	**522.9**
TRANSPORTATION	
Electricity	0.3
Natural gas	0.0
Gasoline	116.5
Diesel fuel	29.5
Jet fuel and avi. gas	15.5
Heavy fuel oil	10.9
Non-conv. energy	0.1
Road	284.0
Rail	11.5
Air	32.2
Sea	32.5
Transportation total	**360.2**
TOTAL OF ALL SECTORS	
Electricity	138.7
Natural gas	177.4
Oil	250.9
- light fuel oil	47.7
- diesel fuel	42.5
- heavy fuel oil	27.4
- gasoline	117.8
- jet fuel and avi. gas	15.5
Coal and coke	708.0
Non-conv. energy	66.6
Total demand	**1 343.5**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and bioma
Transportation: methanol, ethanol and hydr

INDUSTRIAL SECTOR:
Includes the consumption of light and midd

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GE ANNUAL TH RATE	
996 %	1996-2006 %
2.8	1.1
0.5	– 0.2
1.7	– 6.8
3.2	– 14.4
1.4	1.4
4.4	– 12.9
2.1	1.5
1.4	0.3
.1	**0.4**
1.2	1.8
0.8	– 1.3
2.1	– 3.9
3.2	– 4.9
0.7	1.0
1.6	– 8.0
.5	**0.3**
2.9	0.8
0.0	0.4
5.3	1.8
2.9	3.8
0.4	0.7
3.7	3.0
9.5	1.4
1.3	0.6
.3	**0.8**
1.5	7.8
7.2	7.0
1.0	1.3
0.1	0.1
0.5	0.8
1.4	1.2
9.0	9.1
1.3	1.3
0.8	0.4
0.5	0.9
1.3	1.2
.0	**1.3**
1.6	1.1
0.4	0.1
0.0	0.5
6.8	– 6.8
0.9	0.3
0.9	0.9
1.9	1.3
0.5	0.8
1.5	1.4
1.7	1.0
.6	**0.8**

c feet
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MEDEE 3 – SC3

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	42.9	51.8	47.8	57.2	55.9	66.2	60.9	70.0	63.7	71.4	2.7	1.3
Natural gas	26.6	9.4	34.5	12.1	34.3	11.9	34.7	11.7	34.4	11.3	2.6	0.0
Oil	36.7	27.6	25.2	18.7	12.6	9.1	8.0	5.6	6.8	4.6	– 10.3	– 6.2
– light fuel oil	33.1	24.9	21.4	16.0	8.5	6.2	3.4	2.4	1.6	1.1	– 12.7	– 15.3
– diesel fuel	1.5	1.1	1.7	1.3	2.0	1.5	2.3	1.7	2.7	1.9	2.8	2.9
– heavy fuel oil	0.8	0.6	0.5	0.4	0.2	0.2	0.1	0.1	0.0	0.0	– 12.5	– 14.9
– gasoline	1.3	0.9	1.6	1.1	1.9	1.2	2.2	1.4	2.5	1.6	3.9	2.8
Non-conv. energy	33.4	11.2	35.9	11.9	38.9	12.8	40.0	12.8	40.9	12.7	1.5	0.5
Residential total	**298.1**	**100.0**	**300.6**	**100.0**	**304.2**	**100.0**	**313.2**	**100.0**	**321.2**	**100.0**	**0.2**	**0.5**
COMMERCIAL												
Electricity	24.7	54.8	24.5	51.7	27.3	52.5	30.4	53.9	33.5	56.1	1.0	2.1
Natural gas	38.3	24.9	41.4	25.6	53.2	29.9	61.1	31.7	68.1	33.4	3.3	2.5
Oil	14.5	20.3	16.9	22.6	14.4	17.6	12.8	14.4	9.9	10.5	– 0.0	– 3.7
– light fuel oil	9.1	12.6	10.0	13.1	8.6	10.2	6.8	7.5	4.8	5.0	– 0.6	– 5.6
– diesel fuel	2.4	3.3	2.5	3.2	2.8	3.3	3.0	3.3	3.3	3.5	1.6	1.9
– heavy fuel oil	3.0	4.5	4.4	6.3	3.1	4.0	2.9	3.5	1.8	2.0	0.3	– 5.4
Commercial total	**162.3**	**100.0**	**170.5**	**100.0**	**187.4**	**100.0**	**203.3**	**100.0**	**215.0**	**100.0**	**1.4**	**1.4**
INDUSTRIAL												
Electricity	70.8	48.7	68.7	42.1	79.3	43.6	94.3	48.1	109.4	52.3	1.1	3.3
Natural gas	112.5	22.7	169.6	30.5	173.4	27.9	164.5	24.6	150.0	21.0	4.4	– 1.4
Oil	27.4	12.2	26.7	10.6	30.4	10.8	30.4	10.0	31.6	9.7	1.0	0.4
– light fuel oil	5.5	2.4	4.5	1.7	5.3	1.8	4.7	1.5	4.7	1.4	– 0.4	– 1.2
– diesel fuel	9.2	3.9	9.8	3.8	11.6	4.0	13.0	4.1	14.6	4.3	2.4	2.3
– heavy fuel oil	12.7	5.9	12.3	5.1	13.5	5.0	12.7	4.4	12.4	4.0	0.6	– 0.8
Coal and coke	708.0	3.6	894.3	4.1	996.6	4.1	1 091.8	4.2	1 184.9	4.2	3.5	1.7
Non-conv. energy	66.6	12.7	74.4	12.7	88.8	13.6	92.5	13.1	95.5	12.7	2.9	0.7
Industrial total	**522.9**	**100.0**	**586.8**	**100.0**	**654.6**	**100.0**	**705.4**	**100.0**	**752.5**	**100.0**	**2.3**	**1.4**
TRANSPORTATION												
Electricity	0.3	0.3	0.4	0.4	0.5	0.4	0.7	0.6	1.0	0.8	3.5	7.8
Natural gas	0.0	0.0	1.5	0.4	3.0	0.8	4.6	1.2	6.4	1.4	79.9	7.8
Gasoline	116.5	65.0	110.3	62.1	114.4	59.1	124.4	58.9	139.5	59.4	– 0.2	2.0
Diesel fuel	29.5	18.4	30.7	19.3	36.0	20.8	37.5	19.8	39.0	18.5	2.0	0.8
Jet fuel and avi. gas	15.5	8.9	15.6	9.1	18.0	9.6	19.5	9.5	20.8	9.2	1.5	1.5
Heavy fuel oil	10.9	7.3	11.9	8.1	13.4	8.3	14.9	8.5	16.4	8.4	2.1	2.0
Non-conv. energy	0.1	0.0	2.3	0.6	3.5	0.9	6.4	1.5	10.6	2.2	42.7	11.7
Road	284.0	78.8	276.5	77.5	298.1	76.6	325.5	76.7	364.1	77.2	0.5	2.0
Rail	11.5	3.2	12.3	3.4	13.0	3.3	13.5	3.2	14.0	3.0	1.2	0.7
Air	32.2	8.9	32.4	9.1	37.4	9.6	40.5	9.5	43.8	9.3	1.5	1.6
Sea	32.5	9.0	35.0	9.8	39.6	10.2	43.6	10.3	47.9	10.2	2.0	1.9
Transportation total	**360.2**	**100.0**	**356.9**	**100.0**	**389.1**	**100.0**	**424.6**	**100.0**	**471.9**	**100.0**	**0.8**	**1.9**
TOTAL OF ALL SECTORS												
Electricity	138.7	37.2	141.3	36.0	163.1	38.2	186.3	40.7	207.6	42.4	1.6	2.4
Natural gas	177.4	13.9	247.0	18.4	263.9	18.1	265.0	17.0	258.9	15.5	4.0	– 0.2
Oil	250.6	40.0	237.2	36.0	239.1	33.3	247.4	32.1	264.0	31.9	– 0.5	0.9
– light fuel oil	47.7	8.0	35.9	5.7	22.3	3.3	14.9	2.0	11.1	1.4	– 7.3	– 6.8
– diesel fuel	42.5	7.1	44.7	7.1	52.4	7.7	55.8	7.6	59.6	7.6	2.1	1.3
– heavy fuel oil	27.4	4.9	29.2	5.0	30.2	4.8	30.6	4.5	30.6	4.2	1.0	0.1
– gasoline	117.8	17.6	111.8	15.9	116.3	15.2	126.6	15.5	142.0	16.2	– 0.1	2.0
– jet fuel and avi. gas	15.5	2.4	15.6	2.3	18.0	2.4	19.5	2.5	20.8	2.5	1.5	1.5
Coal and coke	708.0	1.4	894.3	1.7	996.6	1.7	1 091.8	1.8	1 184.9	1.8	3.5	1.7
Non-conv. energy	100.1	7.5	112.6	8.0	131.2	8.5	138.9	8.4	147.0	8.3	2.7	1.1
Total demand	**1 343.8**	**100.0**	**1 414.8**	**100.0**	**1 535.3**	**100.0**	**1 646.5**	**100.0**	**1 760.8**	**100.0**	**1.3**	**1.4**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass
Transportation: methanol, ethanol and hydrogen

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries

notes: – Electricity: in TWh
– Natural gas: in billions of cubic feet
– Oil: in thousands of barrels/day
– Coal and coke: in thousands of short tons
– Others: in petajoules

Gouvernement du Québec
Ministère de l'Énergie et des Ressources

(1)

MEDEE 3 – SC1

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	154.4	51.8	178.4	60.4	203.4	67.7	220.0	71.3	228.9	72.5	2.8	1.2
Natural gas	28.1	9.4	35.5	12.0	32.9	11.0	32.4	10.5	32.1	10.2	1.6	-0.2
Oil	82.2	27.6	45.0	15.2	25.1	8.4	16.5	5.3	14.5	4.6	-11.2	-5.3
- light fuel oil	74.3	24.9	37.0	12.5	16.4	5.5	6.7	2.2	3.4	1.1	-14.0	-14.6
- diesel fuel	3.4	1.1	3.8	1.3	4.5	1.5	5.2	1.7	6.0	1.9	2.8	2.9
- heavy fuel oil	1.9	0.6	1.0	0.3	0.4	0.1	0.2	0.1	0.1	0.0	-14.4	-12.9
- gasoline	2.6	0.9	3.2	1.1	3.8	1.3	4.4	1.4	5.0	1.6	3.9	2.8
Non-conv. energy	33.4	11.2	36.4	12.3	38.9	13.0	39.8	12.9	40.4	12.8	1.5	0.4
Residential total	**298.1**	**100.0**	**295.3**	**100.0**	**300.3**	**100.0**	**308.7**	**100.0**	**315.9**	**100.0**	**0.1**	**0.5**
COMMERCIAL												
Electricity	88.9	54.8	91.2	54.5	102.4	56.3	116.4	59.5	135.2	65.9	1.4	2.8
Natural gas	40.4	24.9	44.0	26.3	52.7	29.0	55.7	28.5	50.7	24.7	2.7	-0.4
Oil	33.0	20.3	32.1	19.2	26.9	14.8	23.4	12.0	19.2	9.4	-2.0	-3.3
- light fuel oil	20.4	12.6	18.6	11.1	14.7	8.1	12.3	6.3	9.3	4.5	-3.2	-4.5
- diesel fuel	5.3	3.3	5.5	3.3	6.2	3.4	6.8	3.5	7.5	3.7	1.6	1.9
- heavy fuel oil	7.3	4.5	8.0	4.8	6.0	3.3	4.3	2.2	2.4	1.2	-1.9	-8.8
Commercial total	**162.3**	**100.0**	**167.3**	**100.0**	**182.0**	**100.0**	**195.5**	**100.0**	**205.1**	**100.0**	**1.2**	**1.2**
INDUSTRIAL												
Electricity	254.9	48.7	261.1	45.4	325.8	49.9	374.2	53.0	431.5	56.9	2.5	2.8
Natural gas	118.7	22.7	155.9	27.1	150.0	23.0	146.8	20.8	141.0	18.6	2.4	-0.6
Oil	63.7	12.2	59.5	10.3	60.4	9.2	61.7	8.7	56.9	7.5	-0.5	-0.6
- light fuel oil	12.4	2.4	10.2	1.8	8.7	1.3	8.0	1.1	5.5	0.7	-3.5	-4.5
- diesel fuel	20.6	3.9	22.1	3.8	26.0	4.0	29.1	4.1	32.7	4.3	2.4	2.3
- heavy fuel oil	30.7	5.9	27.2	4.7	25.7	3.9	24.6	3.5	18.7	2.5	-1.8	-3.1
Coal and coke	19.0	3.6	24.0	4.2	28.3	4.3	30.8	4.4	33.5	4.4	4.1	1.7
Non-conv. energy	66.6	12.7	74.4	12.9	88.8	13.6	92.5	13.1	95.5	12.6	2.9	0.7
Industrial total	**522.9**	**100.0**	**574.9**	**100.0**	**653.3**	**100.0**	**706.0**	**100.0**	**758.4**	**100.0**	**2.3**	**1.5**
TRANSPORTATION												
Electricity	1.2	0.3	1.3	0.4	1.7	0.5	2.5	0.6	3.6	0.9	3.5	7.8
Natural gas	0.0	0.0	2.5	0.7	7.1	1.9	8.6	2.2	12.0	2.9	94.9	5.4
Gasoline	234.2	65.0	214.0	61.1	206.1	55.9	211.0	53.9	223.0	53.0	-1.3	0.8
Diesel fuel	66.1	18.4	67.8	19.4	76.4	20.7	79.4	20.3	80.8	19.2	1.5	0.6
Jet fuel and avi. gas	32.2	8.9	31.9	9.1	35.1	9.5	37.0	9.5	38.2	9.1	0.9	0.8
Heavy fuel oil	26.4	7.3	28.2	8.1	31.1	8.4	34.6	8.8	37.6	8.9	1.7	1.9
Non-conv. energy	0.1	0.0	4.4	1.3	10.9	3.0	18.4	4.7	25.6	6.1	59.9	8.9
Road	284.0	78.8	271.2	77.5	281.7	76.5	297.9	76.1	320.4	76.1	-0.1	1.3
Rail	11.5	3.2	12.1	3.5	12.8	3.5	13.5	3.4	14.0	3.3	1.1	0.9
Air	32.2	8.9	31.9	9.1	35.1	9.5	37.0	9.5	39.0	9.3	0.9	1.1
Sea	32.5	9.0	34.3	9.8	38.0	10.3	41.8	10.7	45.5	10.8	1.6	1.8
Transportation total	**360.2**	**100.0**	**350.1**	**100.0**	**368.4**	**100.0**	**391.5**	**100.0**	**420.8**	**100.0**	**0.2**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	499.4	37.2	532.0	38.3	633.3	42.1	713.1	44.5	799.2	47.0	2.4	2.4
Natural gas	187.2	13.9	237.9	17.1	242.7	16.1	243.5	15.2	235.8	13.9	2.6	-0.3
Oil	537.8	40.0	478.5	34.5	461.1	30.7	463.6	28.9	470.2	27.7	-1.5	0.2
- light fuel oil	107.1	8.0	65.8	4.7	39.8	2.6	27.0	1.7	18.2	1.1	-9.4	-7.5
- diesel fuel	95.4	7.1	99.2	7.1	113.1	7.5	120.5	7.5	127.0	7.5	1.7	1.2
- heavy fuel oil	66.3	4.9	64.4	4.6	63.2	4.2	63.7	4.0	58.8	3.5	-0.5	-0.7
- gasoline	236.8	17.6	217.2	15.7	209.9	14.0	215.4	13.4	228.0	13.4	-1.2	0.8
- jet fuel and avi. gas	32.2	2.4	31.9	2.3	35.1	2.3	37.0	2.3	38.2	2.2	0.9	0.8
Coal and coke	19.0	1.4	24.0	1.7	28.3	1.9	30.8	1.9	33.5	2.0	4.1	1.7
Non-conv. energy	100.1	7.5	115.2	8.3	138.6	9.2	150.7	9.4	161.5	9.5	3.3	1.5
Total demand	**1 343.5**	**100.0**	**1 387.0**	**100.0**	**1 504.0**	**100.0**	**1 601.7**	**100.0**	**1 700.2**	**100.0**	**1.1**	**1.2**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

SCENARIOS FOR QUEBEC'S ENERGY DEMAND INCLUDING TOTAL WOOD CONSUMPTION IN PETAJOULES

Québec

AVERAGE ANNUAL GROWTH RATE		
%	1986-1996 %	1996-2006 %
72.5	2.8	1.2
10.2	1.6	−0.2
4.6	−11.2	−5.3
1.1	−14.0	−14.6
1.9	2.8	2.9
0.0	−14.4	−12.9
1.6	3.9	2.8
12.8	1.5	0.4
100.0	**0.1**	**0.5**
65.9	1.4	2.8
24.7	2.7	−0.4
9.4	−2.0	−3.3
4.5	−3.2	−4.5
3.7	1.6	1.9
1.2	−1.9	−8.8
100.0	**1.2**	**1.2**
56.9	2.5	2.8
18.6	2.4	−0.6
7.5	−0.5	−0.6
0.7	−3.5	−4.5
4.3	2.4	2.3
2.5	−1.8	−3.1
4.4	4.1	1.7
12.6	2.9	0.7
100.0	**2.3**	**1.5**
0.9	3.5	7.8
2.9	94.9	5.4
53.0	−1.3	0.8
19.2	1.5	0.6
9.1	0.9	0.8
8.9	1.7	1.9
6.1	59.9	8.9
76.1	−0.1	1.3
3.3	1.1	0.9
9.3	0.9	1.1
10.8	1.6	1.8
100.0	**0.2**	**1.3**
47.0	2.4	2.4
13.9	2.6	−0.3
27.7	−1.5	0.2
1.1	−9.4	−7.5
7.5	1.7	1.2
3.5	−0.5	−0.7
13.4	−1.2	0.8
2.2	0.9	0.8
2.0	4.1	1.7
9.5	3.3	1.5
100.0	**1.1**	**1.2**

MEDEE 3 – SC2

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	154.4	51.8	179.1	61.5	203.4	68.9	219.4	72.6	227.6	73.9	2.8	1.1
Natural gas	28.1	9.4	32.1	11.0	29.6	10.0	29.2	9.7	29.0	9.4	0.5	−0.2
Oil	82.2	27.6	44.0	15.1	23.6	8.0	14.5	4.8	11.7	3.8	−11.7	−6.8
- light fuel oil	74.3	24.9	36.6	12.6	16.1	5.5	6.7	2.2	3.4	1.1	−14.2	−14.4
- diesel fuel	3.4	1.1	3.5	1.2	3.9	1.3	4.1	1.4	4.5	1.5	1.4	1.4
- heavy fuel oil	1.9	0.6	1.0	0.3	0.4	0.1	0.2	0.1	0.1	0.0	−14.4	−12.9
- gasoline	2.6	0.9	2.9	1.0	3.2	1.1	3.5	1.2	3.7	1.2	2.1	1.5
Non-conv. energy	33.4	11.2	36.1	12.4	38.5	13.0	39.3	13.0	39.8	12.9	1.4	0.3
Residential total	**298.1**	**100.0**	**291.3**	**100.0**	**295.1**	**100.0**	**302.4**	**100.0**	**308.1**	**100.0**	**−0.1**	**0.4**
COMMERCIAL												
Electricity	88.9	54.8	88.1	53.9	100.3	58.7	109.6	62.4	119.5	67.9	1.2	1.8
Natural gas	40.4	24.9	42.8	26.2	43.8	25.6	43.4	24.7	38.5	21.9	0.8	−1.3
Oil	33.0	20.3	32.5	19.9	26.7	15.6	22.6	12.9	18.0	10.2	−2.1	−3.9
- light fuel oil	20.4	12.6	18.9	11.6	14.8	8.7	11.9	6.8	9.0	5.1	−3.2	−4.9
- diesel fuel	5.3	3.3	5.3	3.2	5.7	3.3	6.0	3.4	6.3	3.6	0.7	1.0
- heavy fuel oil	7.3	4.5	8.3	5.1	6.2	3.6	4.7	2.7	2.7	1.5	−1.6	−8.0
Commercial total	**162.3**	**100.0**	**163.4**	**100.0**	**170.8**	**100.0**	**175.6**	**100.0**	**176.0**	**100.0**	**0.5**	**0.3**
INDUSTRIAL												
Electricity	254.9	48.7	242.5	43.0	338.1	56.7	346.9	55.9	367.5	56.8	2.9	0.8
Natural gas	118.7	22.7	171.4	30.4	118.4	19.9	123.9	20.0	123.6	19.1	−0.0	0.4
Oil	63.7	12.2	56.1	9.9	36.9	6.2	42.2	6.8	44.0	6.8	−5.3	1.8
- light fuel oil	12.4	2.4	8.7	1.5	3.1	0.5	4.3	0.7	4.5	0.7	−12.9	3.8
- diesel fuel	20.6	3.9	20.1	3.6	21.4	3.6	22.1	3.6	22.9	3.5	0.4	0.7
- heavy fuel oil	30.7	5.9	27.3	4.8	12.4	2.1	15.8	2.5	16.6	2.6	−8.7	3.0
Coal and coke	19.0	3.6	23.3	4.1	26.9	4.5	28.8	4.6	30.8	4.8	3.5	1.4
Non-conv. energy	66.6	12.7	70.9	12.6	76.0	12.7	78.4	12.6	80.8	12.5	1.3	0.6
Industrial total	**522.9**	**100.0**	**564.2**	**100.0**	**596.3**	**100.0**	**620.2**	**100.0**	**646.7**	**100.0**	**1.3**	**0.8**
TRANSPORTATION												
Electricity	1.2	0.3	1.3	0.4	1.7	0.5	2.5	0.7	3.6	0.9	3.5	7.8
Natural gas	0.0	0.0	1.6	0.5	2.9	0.8	4.3	1.1	5.7	1.4	78.2	7.0
Gasoline	234.2	65.0	214.2	62.0	212.5	59.1	218.5	58.4	242.7	59.5	−1.0	1.3
Diesel fuel	66.1	18.4	66.5	19.2	73.7	20.5	73.9	19.8	74.3	18.2	1.1	0.1
Jet fuel and avi. gas	32.2	8.9	31.4	9.1	34.0	9.5	35.6	9.5	36.9	9.0	0.5	0.8
Heavy fuel oil	26.4	7.3	28.3	8.2	30.3	8.4	32.4	8.7	34.3	8.4	1.4	1.2
Non-conv. energy	0.1	0.0	2.2	0.6	4.4	1.2	6.8	1.8	10.5	2.6	46.0	9.1
Road	284.0	78.8	267.0	77.3	275.0	76.5	284.8	76.1	314.0	77.0	−0.3	1.3
Rail	11.5	3.2	12.0	3.5	12.4	3.4	12.7	3.4	12.9	3.2	0.8	0.4
Air	32.2	8.9	31.4	9.1	34.0	9.5	35.6	9.5	37.3	9.1	0.5	0.9
Sea	32.5	9.0	34.4	10.0	37.0	10.3	39.2	10.5	41.6	10.2	1.3	1.2
Transportation total	**360.2**	**100.0**	**345.5**	**100.0**	**359.5**	**100.0**	**374.0**	**100.0**	**408.0**	**100.0**	**−0.0**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	499.4	37.2	511.0	37.5	643.5	45.3	678.4	46.1	718.2	46.7	2.6	1.1
Natural gas	187.2	13.9	247.9	18.2	194.7	13.7	200.8	13.6	196.8	12.8	0.4	0.1
Oil	537.8	40.0	473.0	34.7	437.7	30.8	439.7	29.9	461.9	30.0	−2.0	0.5
- light fuel oil	107.1	8.0	64.2	4.7	34.0	2.4	22.9	1.6	16.9	1.1	−10.8	−6.8
- diesel fuel	95.4	7.1	95.4	7.0	104.7	7.4	106.1	7.2	108.0	7.0	0.9	0.3
- heavy fuel oil	66.3	4.9	64.9	4.8	49.3	3.5	53.1	3.6	53.7	3.5	−2.9	0.9
- gasoline	236.8	17.6	217.1	15.9	215.7	15.2	222.0	15.1	246.4	16.0	−0.9	1.3
- jet fuel and avi. gas	32.2	2.4	31.4	2.3	34.0	2.4	35.6	2.4	36.9	2.4	0.5	0.8
Coal and coke	19.0	1.4	23.3	1.7	26.9	1.9	28.8	2.0	30.8	2.0	3.5	1.4
Non-conv. energy	100.1	7.5	109.2	8.0	118.9	8.4	124.5	8.5	131.1	8.5	1.7	1.0
Total demand	**1 343.5**	**100.0**	**1 384.4**	**100.0**	**1 421.7**	**100.0**	**1 472.2**	**100.0**	**1 538.8**	**100.0**	**0.6**	**0.8**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

MEDEE 3 – SC3

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	154.4	51.8	172.0	57.2	201.3	66.2	219.2	70.0	229.3	71.4	2.7	1.3
Natural gas	28.1	9.4	36.4	12.1	36.2	11.9	36.6	11.7	36.3	11.3	2.6	0.0
Oil	82.2	27.6	56.3	18.7	27.8	9.1	17.4	5.6	14.7	4.6	−10.3	−6.2
- light fuel oil	74.3	24.9	48.0	16.0	19.0	6.2	7.6	2.4	3.6	1.1	−12.7	−15.3
- diesel fuel	3.4	1.1	3.8	1.3	4.5	1.5	5.2	1.7	6.0	1.9	2.8	2.9
- heavy fuel oil	1.9	0.6	1.3	0.4	0.5	0.2	0.2	0.1	0.1	0.0	−12.5	−14.9
- gasoline	2.6	0.9	3.2	1.1	3.8	1.2	4.4	1.4	5.0	1.6	3.9	2.8
Non-conv. energy	33.4	11.2	35.9	11.9	38.9	12.8	40.0	12.8	40.9	12.7	1.5	0.5
Residential total	**298.1**	**100.0**	**300.6**	**100.0**	**304.2**	**100.0**	**313.2**	**100.0**	**321.2**	**100.0**	**0.2**	**0.5**
COMMERCIAL												
Electricity	88.9	54.8	88.2	51.7	98.4	52.5	109.6	53.9	120.6	56.1	1.0	2.1
Natural gas	40.4	24.9	43.7	25.6	56.1	29.9	64.5	31.7	71.8	33.4	3.3	2.5
Oil	33.0	20.3	38.6	22.6	32.9	17.6	29.2	14.4	22.6	10.5	−0.0	−3.7
- light fuel oil	20.4	12.6	22.4	13.1	19.2	10.2	15.3	7.5	10.8	5.0	−0.6	−5.6
- diesel fuel	5.3	3.3	5.5	3.2	6.2	3.3	6.8	3.3	7.5	3.5	1.6	1.9
- heavy fuel oil	7.3	4.5	10.7	6.3	7.5	4.0	7.1	3.5	4.3	2.0	0.3	−5.4
Commercial total	**162.3**	**100.0**	**170.5**	**100.0**	**187.4**	**100.0**	**203.3**	**100.0**	**215.0**	**100.0**	**1.4**	**1.4**
INDUSTRIAL												
Electricity	254.9	48.7	247.3	42.1	285.6	43.6	339.5	48.1	393.8	52.3	1.1	3.3
Natural gas	118.7	22.7	178.9	30.5	182.9	27.9	173.6	24.6	158.2	21.0	4.4	−1.4
Oil	63.7	12.2	62.2	10.6	70.5	10.8	70.5	10.0	73.2	9.7	1.0	0.4
- light fuel oil	12.4	2.4	10.2	1.7	11.9	1.8	10.6	1.5	10.5	1.4	−0.4	−1.2
- diesel fuel	20.6	3.9	22.1	3.8	26.0	4.0	29.1	4.1	32.7	4.3	2.4	2.3
- heavy fuel oil	30.7	5.9	29.9	5.1	32.6	5.0	30.8	4.4	30.0	4.0	0.6	−0.8
Coal and coke	19.0	3.6	24.0	4.1	26.8	4.1	29.3	4.2	31.8	4.2	3.5	1.7
Non-conv. energy	66.6	12.7	74.4	12.7	88.8	13.6	92.5	13.1	95.5	12.7	2.9	0.7
Industrial total	**522.9**	**100.0**	**586.8**	**100.0**	**654.6**	**100.0**	**705.4**	**100.0**	**752.5**	**100.0**	**2.3**	**1.4**
TRANSPORTATION												
Electricity	1.2	0.3	1.3	0.4	1.7	0.4	2.5	0.6	3.6	0.8	3.5	7.8
Natural gas	0.0	0.0	1.6	0.4	3.2	0.8	4.9	1.2	6.8	1.4	79.9	7.8
Gasoline	234.2	65.0	221.7	62.1	230.1	59.1	250.1	58.9	280.5	59.4	−0.2	2.0
Diesel fuel	66.1	18.4	68.8	19.3	80.8	20.8	84.2	19.8	87.5	18.5	2.0	0.8
Jet fuel and avi. gas	32.2	8.9	32.4	9.1	37.4	9.6	40.5	9.5	43.3	9.2	1.5	1.5
Heavy fuel oil	26.4	7.3	28.8	8.1	32.4	8.3	36.0	8.5	39.6	8.4	2.1	2.0
Non-conv. energy	0.1	0.0	2.3	0.6	3.5	0.9	6.4	1.5	10.6	2.2	42.7	11.7
Road	284.0	78.8	276.5	77.5	298.1	76.6	325.5	76.7	364.1	77.2	0.5	2.0
Rail	11.5	3.2	12.3	3.4	13.0	3.3	13.5	3.2	14.0	3.0	1.2	0.7
Air	32.2	8.9	32.4	9.1	37.4	9.6	40.5	9.5	43.8	9.3	1.5	1.6
Sea	32.5	9.0	35.0	9.8	39.6	10.2	43.6	10.3	47.9	10.2	2.0	1.9
Transportation total	**360.2**	**100.0**	**350.9**	**100.0**	**389.1**	**100.0**	**424.6**	**100.0**	**471.9**	**100.0**	**0.8**	**1.9**
TOTAL OF ALL SECTORS												
Electricity	499.4	37.2	508.8	36.0	587.0	38.2	670.8	40.7	747.3	42.4	1.6	2.4
Natural gas	187.2	13.9	260.6	18.4	278.4	18.1	279.6	17.0	273.1	15.5	4.0	−0.2
Oil	537.8	40.0	508.8	36.0	511.9	33.3	527.9	32.1	561.4	31.9	−0.5	0.9
- light fuel oil	107.1	8.0	80.6	5.7	50.1	3.3	33.5	2.0	24.9	1.4	−7.3	−6.8
- diesel fuel	95.4	7.1	100.2	7.1	117.5	7.7	125.3	7.6	133.7	7.6	2.1	1.3
- heavy fuel oil	66.3	4.9	70.7	5.0	73.0	4.8	74.1	4.5	74.0	4.2	1.0	0.1
- gasoline	236.8	17.6	224.9	15.9	233.9	15.2	254.5	15.5	285.5	16.2	−0.1	2.0
- jet fuel and avi. gas	32.2	2.4	32.4	2.3	37.4	2.4	40.5	2.5	43.3	2.5	1.5	1.5
Coal and coke	19.0	1.4	24.0	1.7	26.8	1.7	29.3	1.8	31.8	1.8	3.5	1.7
Non-conv. energy	100.1	7.5	112.6	8.0	131.2	8.5	138.9	8.4	147.0	8.3	2.7	1.1
Total demand	**1 343.5**	**100.0**	**1 414.8**	**100.0**	**1 535.3**	**100.0**	**1 646.5**	**100.0**	**1 760.6**	**100.0**	**1.3**	**1.4**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

Gouvernement du Québec
Ministère de l'Énergie et des Ressources

SCENARIOS FOR QUEBEC'S ENERGY DEMAND INCLUDING TOTAL WOOD CONSUMPTION IN THOUSANDS OF TOE

MEDEE 3 – SC1

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	3 688.2	51.8	4 261.4	60.4	4 858.6	67.7	5 255.1	71.3	5 467.7	72.5	2.8	1.2
Natural gas	671.2	9.4	848.0	12.0	785.9	11.0	773.9	10.5	766.8	10.2	1.6	-0.2
Oil	1 963.5	27.6	1 074.9	15.2	599.6	8.4	394.1	5.3	346.4	4.6	-11.2	-5.3
- light fuel oil	1 774.8	24.9	883.8	12.5	391.7	5.5	160.0	2.2	81.2	1.1	-14.0	-14.6
- diesel fuel	81.2	1.1	90.8	1.3	107.5	1.5	124.2	1.7	143.3	1.9	2.8	2.9
- heavy fuel oil	45.4	0.6	23.9	0.3	9.6	0.1	4.8	0.1	2.4	0.0	-14.4	-12.9
- gasoline	62.1	0.9	76.4	1.1	90.8	1.3	105.1	1.4	119.4	1.6	3.9	2.8
Non-conv. energy	797.8	11.2	869.5	12.3	929.2	13.0	950.7	12.9	965.0	12.8	1.5	0.4
Residential total	**7 120.7**	**100.0**	**7 053.8**	**100.0**	**7 173.3**	**100.0**	**7 373.9**	**100.0**	**7 545.9**	**100.0**	**0.1**	**0.5**
COMMERCIAL												
Electricity	2 123.6	54.8	2 178.5	54.5	2 446.0	56.3	2 780.4	59.5	3 229.5	65.9	1.4	2.8
Natural gas	965.0	24.9	1 051.0	26.3	1 258.8	29.0	1 330.5	28.5	1 211.1	24.7	2.7	-0.4
Oil	788.3	20.3	766.8	19.2	642.6	14.8	559.0	12.0	458.6	9.4	-2.0	-3.3
- light fuel oil	487.3	12.6	444.3	11.1	351.1	8.1	293.8	6.3	222.1	4.5	-3.2	-4.5
- diesel fuel	126.6	3.3	131.4	3.3	148.1	3.4	162.4	3.5	179.2	3.7	1.6	1.9
- heavy fuel oil	174.4	4.5	191.1	4.8	143.3	3.3	102.7	2.2	57.3	1.2	-1.9	-8.8
Commercial total	**3 876.9**	**100.0**	**3 996.3**	**100.0**	**4 347.4**	**100.0**	**4 669.9**	**100.0**	**4 899.2**	**100.0**	**1.2**	**1.2**
INDUSTRIAL												
Electricity	6 088.8	48.7	6 236.9	45.4	7 782.4	49.9	8 938.5	53.0	10 257.2	56.9	2.5	2.8
Natural gas	2 835.4	22.7	3 724.0	27.1	3 583.1	23.0	3 506.6	20.8	3 368.1	18.6	2.4	-0.6
Oil	1 521.6	12.2	1 421.3	10.3	1 442.8	9.2	1 473.8	8.7	1 359.2	7.5	-0.5	-0.6
- light fuel oil	296.2	2.4	243.6	1.8	207.8	1.3	191.1	1.1	131.4	0.7	-3.5	-4.5
- diesel fuel	492.1	3.9	527.9	3.8	621.1	4.0	695.1	4.1	781.1	4.3	2.4	2.3
- heavy fuel oil	733.3	5.9	649.7	4.7	613.9	3.9	587.6	3.5	446.7	2.5	-1.8	-3.1
Coal and coke	453.9	3.6	573.3	4.2	676.0	4.3	735.7	4.4	800.2	4.4	4.1	1.7
Non-conv. energy	1 590.9	12.7	1 777.2	12.9	2 121.2	13.6	2 209.5	13.1	2 281.2	12.6	2.9	0.7
Industrial total	**12 490.5**	**100.0**	**13 732.6**	**100.0**	**15 605.4**	**100.0**	**16 864.2**	**100.0**	**18 115.9**	**100.0**	**2.3**	**1.5**
TRANSPORTATION												
Electricity	28.7	0.3	31.1	0.4	40.6	0.5	59.7	0.6	86.0	0.9	3.5	7.8
Natural gas	0.2	0.0	59.7	0.7	169.6	1.9	205.4	2.2	286.6	2.9	94.9	5.4
Gasoline	5 594.3	65.0	5 111.8	61.1	4 923.1	55.9	5 040.2	53.9	5 326.8	53.0	-1.3	0.8
Diesel fuel	1 578.9	18.4	1 619.5	19.4	1 825.0	20.7	1 896.6	20.3	1 930.1	19.2	1.5	0.6
Jet fuel and avi. gas	769.2	8.9	762.0	9.1	838.4	9.5	883.8	9.5	912.5	9.1	0.9	0.8
Heavy fuel oil	630.6	7.3	673.6	8.1	742.9	8.4	826.5	8.8	898.2	8.9	1.7	1.9
Non-conv. energy	2.4	0.0	105.1	1.3	260.4	3.0	439.5	4.7	611.5	6.1	59.9	8.9
Road	6 783.9	78.8	6 478.2	77.5	6 729.0	76.5	7 115.9	76.1	7 653.4	76.1	-0.1	1.3
Rail	274.7	3.2	289.0	3.5	305.8	3.5	322.5	3.4	334.4	3.3	1.1	0.9
Air	769.2	8.9	762.0	9.1	838.4	9.5	883.8	9.5	931.6	9.3	0.9	1.1
Sea	776.3	9.0	819.3	9.8	907.7	10.3	998.5	10.7	1 086.9	10.8	1.6	1.8
Transportation total	**8 604.3**	**100.0**	**8 362.8**	**100.0**	**8 800.0**	**100.0**	**9 351.8**	**100.0**	**10 051.6**	**100.0**	**0.2**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	11 929.2	37.2	12 707.9	38.3	15 127.6	42.1	17 033.8	44.5	19 090.5	47.0	2.4	2.4
Natural gas	4 471.9	13.9	5 682.7	17.1	5 797.4	16.1	5 816.5	15.2	5 632.6	13.9	2.6	-0.3
Oil	12 846.4	40.0	11 429.9	34.5	11 014.3	30.7	11 074.0	28.9	11 231.7	27.7	-1.5	0.2
- light fuel oil	2 558.3	8.0	1 571.8	4.7	950.7	2.6	644.9	1.7	434.7	1.1	-9.4	-7.5
- diesel fuel	2 278.8	7.1	2 369.6	7.1	2 701.6	7.5	2 878.4	7.5	3 033.6	7.5	1.7	1.2
- heavy fuel oil	1 583.7	4.9	1 538.3	4.6	1 509.7	4.2	1 521.6	4.0	1 404.6	3.5	-0.5	-0.7
- gasoline	5 656.4	17.6	5 188.3	15.7	5 013.9	14.0	5 145.3	13.4	5 446.2	13.4	-1.2	0.8
- jet fuel and avi. gas	769.2	2.4	762.0	2.3	838.4	2.3	883.8	2.3	912.5	2.2	0.9	0.8
Coal and coke	453.9	1.4	573.3	1.7	676.0	1.9	735.7	1.9	800.2	2.0	4.1	1.7
Non-conv. energy	2 391.1	7.5	2 751.8	8.3	3 310.7	9.2	3 599.8	9.4	3 857.8	9.5	3.3	1.5
Total demand	**32 092.4**	**100.0**	**33 145.6**	**100.0**	**35 926.0**	**100.0**	**38 259.8**	**100.0**	**40 612.7**	**100.0**	**1.1**	**1.2**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

MEDEE 3 – SC2

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	1996-2006 %
RESIDENTIAL												
Electricity	3 688.2	51.8	4 278.2	61.5	4 858.6	68.9	5 240.8	72.6	5 436.7	73.9	2.8	1.1
Natural gas	671.2	9.4	766.8	11.0	707.1	10.0	697.5	9.7	692.7	9.4	0.5	-0.2
Oil	1 963.5	27.6	1 051.0	15.1	563.7	8.0	346.4	4.8	279.5	3.8	-11.7	-6.8
- light fuel oil	1 774.8	24.9	874.3	12.6	384.6	5.5	160.0	2.2	81.2	1.1	-14.2	-14.4
- diesel fuel	81.2	1.1	83.6	1.2	93.2	1.3	97.9	1.4	107.5	1.5	1.4	1.4
- heavy fuel oil	45.4	0.6	23.9	0.3	9.6	0.1	4.8	0.1	2.4	0.0	-14.4	-12.9
- gasoline	62.1	0.9	69.3	1.0	76.4	1.1	83.6	1.2	88.4	1.2	2.1	1.5
Non-conv. energy	797.8	11.2	862.3	12.4	919.6	13.0	938.8	13.0	950.7	12.9	1.4	0.3
Residential total	**7 120.7**	**100.0**	**6 958.3**	**100.0**	**7 049.1**	**100.0**	**7 223.4**	**100.0**	**7 359.6**	**100.0**	**-0.1**	**0.4**
COMMERCIAL												
Electricity	2 123.6	54.8	2 104.4	53.9	2 395.9	58.7	2 618.0	62.4	2 854.5	67.9	1.2	1.8
Natural gas	965.0	24.9	1 022.4	26.2	1 046.3	25.6	1 036.7	24.7	919.6	21.9	0.8	-1.3
Oil	788.3	20.3	776.3	19.9	637.8	15.6	539.8	12.9	430.0	10.2	-2.1	-3.9
- light fuel oil	487.3	12.6	451.5	11.6	353.5	8.7	284.3	6.8	215.0	5.1	-3.2	-4.9
- diesel fuel	126.6	3.3	126.6	3.2	136.2	3.3	143.3	3.4	150.5	3.6	0.7	1.0
- heavy fuel oil	174.4	4.5	198.3	5.1	148.1	3.6	112.3	2.7	64.5	1.5	-1.6	-8.0
Commercial total	**3 876.9**	**100.0**	**3 903.1**	**100.0**	**4 079.9**	**100.0**	**4 194.6**	**100.0**	**4 204.1**	**100.0**	**0.5**	**0.3**
INDUSTRIAL												
Electricity	6 088.8	48.7	5 792.6	43.0	8 076.2	56.7	8 286.4	55.9	8 778.5	56.8	2.9	0.8
Natural gas	2 835.4	22.7	4 094.2	30.4	2 828.2	19.9	2 959.6	20.0	2 952.4	19.1	-0.0	0.4
Oil	1 521.6	12.2	1 340.1	9.9	881.4	6.2	1 008.0	6.8	1 051.0	6.8	-5.3	1.8
- light fuel oil	296.2	2.4	207.8	1.5	74.0	0.5	102.7	0.7	107.5	0.7	-12.9	3.8
- diesel fuel	492.1	3.9	480.1	3.6	511.2	3.6	527.9	3.6	547.0	3.5	0.4	0.7
- heavy fuel oil	733.3	5.9	652.1	4.8	296.2	2.1	377.4	2.5	396.5	2.6	-8.7	3.0
Coal and coke	453.9	3.6	556.6	4.1	642.6	4.5	687.9	4.6	735.7	4.8	3.5	1.4
Non-conv. energy	1 590.9	12.7	1 693.6	12.6	1 815.4	12.7	1 872.7	12.6	1 930.1	12.5	1.3	0.6
Industrial total	**12 490.5**	**100.0**	**13 477.0**	**100.0**	**14 243.8**	**100.0**	**14 814.7**	**100.0**	**15 447.7**	**100.0**	**1.3**	**0.8**
TRANSPORTATION												
Electricity	28.7	0.3	31.1	0.4	40.6	0.5	59.7	0.7	86.0	0.9	3.5	7.8
Natural gas	0.2	0.0	38.2	0.5	69.3	0.8	102.7	1.1	136.2	1.4	78.2	7.0
Gasoline	5 594.3	65.0	5 116.6	62.0	5 076.0	59.1	5 219.3	58.4	5 797.4	59.5	-1.0	1.3
Diesel fuel	1 578.9	18.4	1 588.5	19.2	1 760.5	20.5	1 765.2	19.8	1 774.8	18.2	1.1	0.1
Jet fuel and avi. gas	769.2	8.9	750.1	9.1	812.2	9.5	850.4	9.5	881.4	9.0	0.5	0.8
Heavy fuel oil	630.6	7.3	676.0	8.2	723.8	8.4	773.9	8.7	819.3	8.4	1.4	1.2
Non-conv. energy	2.4	0.0	52.6	0.6	105.1	1.2	162.4	1.8	250.8	2.6	46.0	9.1
Road	6 783.9	78.8	6 377.8	77.3	6 568.9	76.5	6 803.0	76.1	7 500.5	77.0	-0.3	1.3
Rail	274.7	3.2	286.6	3.5	296.2	3.4	303.4	3.4	308.1	3.2	0.8	0.4
Air	769.2	8.9	750.1	9.1	812.2	9.5	850.4	9.5	891.0	9.1	0.5	0.9
Sea	776.3	9.0	821.7	10.0	863.8	10.3	936.4	10.5	993.7	10.2	1.3	1.2
Transportation total	**8 604.3**	**100.0**	**8 253.0**	**100.0**	**8 587.4**	**100.0**	**8 933.7**	**100.0**	**9 745.9**	**100.0**	**-0.0**	**1.3**
TOTAL OF ALL SECTORS												
Electricity	11 929.2	37.2	12 206.3	37.5	15 371.3	45.3	16 204.9	46.1	17 155.6	46.7	2.6	1.1
Natural gas	4 471.9	13.9	5 921.6	18.2	4 650.8	13.7	4 796.5	13.6	4 701.0	12.8	0.4	0.1
Oil	12 846.4	40.0	11 298.6	34.7	10 455.3	30.8	10 503.1	29.9	11 033.4	30.0	-2.0	0.5
- light fuel oil	2 558.3	8.0	1 533.5	4.7	812.2	2.4	547.0	1.6	403.7	1.1	-10.8	-6.8
- diesel fuel	2 278.8	7.1	2 278.8	7.0	2 501.0	7.4	2 534.4	7.2	2 579.8	7.0	0.9	0.3
- heavy fuel oil	1 583.7	4.9	1 550.3	4.8	1 177.6	3.5	1 268.4	3.6	1 282.7	3.5	-2.9	0.9
- gasoline	5 656.4	17.6	5 185.9	15.9	5 152.4	15.2	5 302.9	15.1	5 885.8	16.0	-0.9	1.3
- jet fuel and avi. gas	769.2	2.4	750.1	2.3	812.2	2.4	850.4	2.4	881.4	2.4	0.5	0.8
Coal and coke	453.9	1.4	556.6	1.7	642.6	1.9	687.9	2.0	735.7	2.0	3.5	1.4
Non-conv. energy	2 391.1	7.5	2 608.5	8.0	2 840.2	8.4	2 973.9	8.5	3 131.6	8.5	1.7	1.0
Total demand	**32 092.4**	**100.0**	**32 591.4**	**100.0**	**33 960.1**	**100.0**	**35 166.4**	**100.0**	**36 757.3**	**100.0**	**0.6**	**0.8**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass.
Transportation: methanol, ethanol and hydrogen.

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries.

MEDEE 3 – SC3

RESIDENTIAL	
Electricity	
Natural gas	
Oil	
- light fuel oil	
- diesel fuel	
- heavy fuel oil	
- gasoline	
Non-conv. energy	
Residential total	7
COMMERCIAL	
Electricity	
Natural gas	
Oil	
- light fuel oil	
- diesel fuel	
- heavy fuel oil	
Commercial total	3
INDUSTRIAL	
Electricity	
Natural gas	
Oil	
- light fuel oil	
- diesel fuel	
- heavy fuel oil	
Coal and coke	
Non-conv. energy	
Industrial total	12
TRANSPORTATION	
Electricity	
Natural gas	
Gasoline	
Diesel fuel	
Jet fuel and avi. gas	
Heavy fuel oil	
Non-conv. energy	
Road	
Rail	
Air	
Sea	
Transportation total	8
TOTAL OF ALL SECTORS	
Electricity	11
Natural gas	4
Oil	12
- light fuel oil	2
- diesel fuel	2
- heavy fuel oil	1
- gasoline	5
- jet fuel and avi. gas	
Coal and coke	
Non-conv. energy	2
Total demand	32

NON-CONVENTIONAL ENERGY
Residential and industrial: wood
Transportation: methanol, ethan

INDUSTRIAL SECTOR:
Includes the consumption of ligh

LUDING
F TOE

Québec

AVERAGE ANNUAL GROWTH RATE	
1986-1996 %	1996-2006 %
2.8	1.1
0.5	-0.2
-11.7	-6.8
-14.2	-14.4
1.4	1.4
-14.4	-12.9
2.1	1.5
1.4	0.3
-0.1	**0.4**
1.2	1.8
0.8	-1.3
-2.1	-3.9
-3.2	-4.9
0.7	1.0
-1.6	-8.0
0.5	**0.3**
2.9	0.8
-0.0	0.4
-5.3	1.8
-12.9	3.8
0.4	0.7
-8.7	3.0
3.5	1.4
1.3	0.6
1.3	**0.8**
3.5	7.8
78.2	7.0
-1.0	1.3
1.1	0.1
0.5	0.8
1.4	1.2
46.0	9.1
-0.3	1.3
0.8	0.4
0.5	0.9
1.3	1.2
-0.0	**1.3**
2.6	1.1
0.4	0.1
-2.0	0.5
-10.8	-6.8
0.9	0.3
-2.9	0.9
-0.9	1.3
0.5	0.8
3.5	1.4
1.7	1.0
0.6	**0.8**

MEDEE 3 – SC3

	1986	%	1991	%	1996	%	2001	%	2006	%	AVERAGE ANNUAL GROWTH RATE 1986-1996 %	AVERAGE ANNUAL GROWTH RATE 1996-2006 %
RESIDENTIAL												
Electricity	3 688.2	51.8	4 108.6	57.2	4 808.5	66.2	5 236.0	70.0	5 477.3	71.4	2.7	1.3
Natural gas	671.2	9.4	869.5	12.1	864.7	11.9	874.3	11.7	867.1	11.3	2.6	0.0
Oil	1 963.5	27.6	1 344.8	18.7	664.1	9.1	415.6	5.6	351.1	4.6	-10.3	-6.2
- light fuel oil	1 774.8	24.9	1 146.6	16.0	453.9	6.2	181.5	2.4	86.0	1.1	-12.7	-15.3
- diesel fuel	81.2	1.1	90.8	1.3	107.5	1.5	124.2	1.7	143.3	1.9	2.8	2.9
- heavy fuel oil	45.4	0.6	31.1	0.4	11.9	0.2	4.8	0.1	2.4	0.0	-12.5	-14.9
- gasoline	62.1	0.9	76.4	1.1	90.8	1.2	105.1	1.4	119.4	1.6	3.9	2.8
Non-conv. energy	797.8	11.2	857.5	11.9	929.2	12.8	955.5	12.8	977.0	12.7	1.5	0.5
Residential total	**7 120.7**	**100.0**	**7 180.4**	**100.0**	**7 266.4**	**100.0**	**7 481.4**	**100.0**	**7 672.5**	**100.0**	**0.2**	**0.5**
COMMERCIAL												
Electricity	2 123.6	54.8	2 106.8	51.7	2 350.5	52.5	2 618.0	53.9	2 880.8	56.1	1.0	2.1
Natural gas	965.0	24.9	1 043.9	25.6	1 340.1	29.9	1 540.7	31.7	1 715.1	33.4	3.3	2.5
Oil	788.3	20.3	922.0	22.6	785.9	17.6	697.5	14.4	539.8	10.5	-0.0	-3.7
- light fuel oil	487.3	12.6	535.1	13.1	458.6	10.2	365.5	7.5	258.0	5.0	-0.6	-5.6
- diesel fuel	126.6	3.3	131.4	3.2	148.1	3.3	162.4	3.3	179.2	3.5	1.6	1.9
- heavy fuel oil	174.4	4.5	255.6	6.3	179.2	4.0	169.6	3.5	102.7	2.0	0.3	-5.4
Commercial total	**3 876.9**	**100.0**	**4 072.7**	**100.0**	**4 476.4**	**100.0**	**4 856.2**	**100.0**	**5 135.7**	**100.0**	**1.4**	**1.4**
INDUSTRIAL												
Electricity	6 088.8	48.7	5 907.3	42.1	6 822.1	43.6	8 109.6	48.1	9 406.7	52.3	1.1	3.3
Natural gas	2 835.4	22.7	4 273.4	30.5	4 368.9	27.9	4 146.8	24.6	3 778.9	21.0	4.4	-1.4
Oil	1 521.6	12.2	1 485.8	10.6	1 684.0	10.8	1 684.0	10.0	1 748.5	9.7	1.0	0.4
- light fuel oil	296.2	2.4	243.6	1.7	284.3	1.8	253.2	1.5	250.8	1.4	-0.4	-1.2
- diesel fuel	492.1	3.9	527.9	3.8	621.1	4.0	695.1	4.1	781.1	4.3	2.4	2.3
- heavy fuel oil	733.3	5.9	714.2	5.1	778.7	5.0	735.7	4.4	716.6	4.0	0.6	-0.8
Coal and coke	453.9	3.6	573.3	4.1	640.2	4.1	699.9	4.2	759.6	4.2	3.5	1.7
Non-conv. energy	1 590.9	12.7	1 777.2	12.7	2 121.2	13.6	2 209.5	13.1	2 281.2	12.7	2.9	0.7
Industrial total	**12 490.5**	**100.0**	**14 016.9**	**100.0**	**15 636.4**	**100.0**	**16 849.9**	**100.0**	**17 975.0**	**100.0**	**2.3**	**1.4**
TRANSPORTATION												
Electricity	28.7	0.3	31.1	0.4	40.6	0.4	59.7	0.6	86.0	0.8	3.5	7.8
Natural gas	0.2	0.0	38.2	0.4	76.4	0.8	117.0	1.2	162.4	1.4	79.9	7.8
Gasoline	5 594.3	65.0	5 295.7	62.1	5 496.4	59.1	5 974.1	58.9	6 700.3	59.4	-0.2	2.0
Diesel fuel	1 578.9	18.4	1 643.4	19.3	1 930.1	20.8	2 011.3	19.8	2 090.1	18.5	2.0	0.8
Jet fuel and avi. gas	769.2	8.9	773.9	9.1	893.4	9.6	967.4	9.5	1 034.3	9.2	1.5	1.5
Heavy fuel oil	630.6	7.3	687.9	8.1	773.9	8.3	859.9	8.5	945.9	8.4	2.1	2.0
Non-conv. energy	2.4	0.0	54.9	0.6	83.6	0.9	152.9	1.5	253.2	2.2	42.7	11.7
Road	6 783.9	78.8	6 604.8	77.5	7 120.7	76.6	7 775.2	76.7	8 697.3	77.2	0.5	2.0
Rail	274.7	3.2	293.8	3.4	310.5	3.3	322.5	3.2	334.4	3.0	1.2	0.7
Air	769.2	8.9	773.9	9.1	893.4	9.6	967.4	9.5	1 046.3	9.3	1.5	1.6
Sea	776.3	9.0	836.0	9.8	945.9	10.2	1 041.5	10.3	1 144.2	10.2	2.0	1.9
Transportation total	**8 604.3**	**100.0**	**8 525.3**	**100.0**	**9 294.4**	**100.0**	**10 142.4**	**100.0**	**11 272.3**	**100.0**	**0.8**	**1.9**
TOTAL OF ALL SECTORS												
Electricity	11 929.2	37.2	12 153.7	36.0	14 021.7	38.2	16 023.4	40.7	17 850.8	42.4	1.6	2.4
Natural gas	4 471.9	13.9	6 225.0	18.4	6 650.1	18.1	6 678.8	17.0	6 523.5	15.5	4.0	-0.2
Oil	12 846.4	40.0	12 153.7	36.0	12 227.8	33.3	12 609.9	32.1	13 410.2	31.9	-0.5	0.9
- light fuel oil	2 558.3	8.0	1 925.3	5.7	1 196.7	3.3	800.2	2.0	594.8	1.4	-7.3	-6.8
- diesel fuel	2 278.8	7.1	2 393.5	7.1	2 806.7	7.7	2 993.0	7.6	3 193.7	7.6	2.1	1.3
- heavy fuel oil	1 583.7	4.9	1 688.8	5.0	1 743.8	4.8	1 770.0	4.5	1 767.6	4.2	1.0	0.1
- gasoline	5 656.4	17.6	5 372.2	15.9	5 587.2	15.2	6 079.2	15.5	6 819.7	16.2	-0.1	2.0
- jet fuel and avi. gas	769.2	2.4	773.9	2.3	893.4	2.4	967.4	2.5	1 034.3	2.5	1.5	1.5
Coal and coke	453.9	1.4	573.3	1.7	640.2	1.7	699.9	1.8	759.6	1.8	3.5	1.7
Non-conv. energy	2 391.1	7.5	2 689.7	8.0	3 134.0	8.5	3 317.9	8.4	3 511.4	8.3	2.7	1.1
Total demand	**32 092.4**	**100.0**	**33 795.3**	**100.0**	**36 673.7**	**100.0**	**39 329.9**	**100.0**	**42 055.5**	**100.0**	**1.3**	**1.4**

NON-CONVENTIONAL ENERGY FORMS:
Residential and industrial: wood and biomass
Transportation: methanol, ethanol and hydrogen

INDUSTRIAL SECTOR:
Includes the consumption of light and middle distillates, heavy fuel oil and natural gas by refineries

Gouvernement du Québec
Ministère de l'Énergie
et des Ressources